CALLED TO ACCOUNT: CRITERIA IN MATHEMATICS TEACHER EDUCATION

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In this paper we present the conceptual underpinnings of a teacher education project where we attempt to hold the social and mathematical together. We argue that this is done through conceiving of mathematics and mathematics teaching as practices, and the key aspects of a practice are to account for what counts: the criteria of the practice. We show how our programme tries to support teachers' accountability to each other and to the practices of mathematics and teaching. We do this through the artefact of an international test and a series of structured activities, which focus on learner errors in mathematics. We thus subvert the status quo of assessment and accountability – using them as vehicles for teacher development, rather than teacher regulation and denigration.

INTRODUCTION

Across the globe, in the name of accountability, standardised tests are being used to monitor and regulate teachers' practices, to reward and sanction, and "shame and blame" schools and whole countries. Research has shown that these testing practices at best provide more and more data, and at worst lead to resentment and compliance but not to improvement of learning and teaching (Earl & Fullan, 2003; Fuhrman & Elmore, 2004; McNeil, 2000; Walls, 2008). To counter the disempowerment that tests usually produce, we have developed a teacher-education project, using a standardised test together with other forms of data from practice. We argue that standardised tests, if used appropriately, can provide a mechanism for teacher growth and empowerment. In this paper we describe some of the conceptual underpinnings of the project.

In conceptualising our project, we find ourselves firmly in the grasp of the dilemma of mathematical specificity (Valero & Matos, 2000), which questions the extent to which researchers can manage to keep our gaze on both the mathematical and the social and political aspects of teaching and learning. If we argue that both are important, then we need to find ways to keep both in focus, rather than losing one at the expense of the other. Our project draws on notions of accountability to and in practice to argue that the mathematical and the social go hand-in-hand and are inseparable if we want to truly empower teachers through teacher education.

In developing a teacher education programme that does empower teachers, a key principle is that we should not expect dramatic teacher change unconstrained by teachers' current positions and practices and we should strive to work from where teachers are, rather than from some ideal of where they should be. In researching the programme, we would have to try to understand teacher change in more nuanced and textured ways than whether they take on reform practices in the ways in which we want to see them.

THE PROJECT

Our argument is strongly informed by our context – the mathematical experiences and achievements of South African learners. As with all aspects of life in South Africa, the education system is characterized by large disparities between rich and poor, and most of our schools and learners are of very low socio-economic status. Most teachers in South Africa teach big classes in very poorly resourced schools. Disaffection and alienation are rife (Motala & Dieltiens, 2008) and failure rates are high, particularly in mathematics, where failure begins as early as grade 3. Reviewing the research, Taylor, Muller and Vinjevold (2003) conclude that "studies conducted in South Africa from 1998 to 2002 suggest that learners' scores are far below what is expected at all levels of the schooling system, both in relation to other countries, including other African and developing countries and in relation to the expectation of the South African curriculum". Many grade 3 learners struggle with basic skills such as adding and subtracting two-digit numbers that require 'carrying' or 'borrowing'. Learner failure and alienation is compounded through the years of schooling, culminating in very low pass rates in mathematics in the final grade 12 examinations, particularly for black learners.

Any teacher education programme working in South Africa needs to take seriously the mathematical empowerment of teachers and learners. This raises the question of what mathematics might be empowering. One candidate is critical mathematics (Gutstein, 2008). Another is a notion of mathematics as a practice or set of practices (Ball, 2003), which are both reasoned and reasonable (Ball & Bass, 2003). The practice of mathematics includes: symbolising, generalising, solving problems, justifying, explaining and communicating mathematical ideas. Just as mathematics as a knowledge system is a practice, so is mathematics teaching, and a key task for teachers is to work across these two practices to give access to the practice of mathematics to their learners (Ball & Bass, 2003; Brown, Collins, & Duguid, 1989). Our choice of mathematics as a practice allows us to recognise that changes in teaching and learning are not simply about changes in consciousness but are also about extending repertoires of knowledgeably skilled identity (Wenger, 1998).

Our project uses a range of data to help teachers develop their knowledgeably skilled identities within the practices of mathematics and teaching. The data includes test results, curriculum documents, academic papers written for teachers, lesson plans and videotapes of lessons. The project structures a set of activities for teachers over three years:

1. Analyses of learner results on an international standardized, multiple-choice test[1], through an analysis of the distractors on the test;

2. Mapping of the test in relation to the South African mathematics curriculum;

3. Reading and discussions of texts in relation to a learner errors on a concept (our first concept was the equal sign and its meanings);

4. Developing lesson plans drawing on these analyses and discussions, which aim to engage learner errors and misconceptions in relation to the concept;

5. Reflections on videotaped lessons of some teachers teaching from the lesson plans.

The project participants are Grade 3-9 teachers from a number of schools in different socio-economic contexts in Johannesburg. The teachers come with different histories and different taken-for-granted conceptions of mathematics and of teaching mathematics. They meet once a week at our university where they work in small grade-level groups of 3-4 teachers per group, with a team-leader, who is either a member of staff or post-graduate student at our university. Part of activity 4 and activity 5 are conducted in larger groups across grade-levels.

ACCOUNTABILITY IN PRACTICE

The project draws on a number of key understandings of what teacher learning and empowerment might mean. In working with an international standardized test, we consciously move from the use of test data for benchmarking and monitoring teachers' and learners' performance to the use of test data as a vehicle for teacher development. Here we use Earl and Katz' (2005) distinction between "accounting", which is the practice of gathering and organising of data and "accountability", which refers to educational conversations about what the information means and how it can inform teaching and learning. For Earl and Katz, internal accountability is where teachers are "constantly engaged in careful analysis of their beliefs and their practices, to help them do things that they don't yet know how to do" (2005, p.63). This implies that accountability conversations can give participants imaginations for possibilities that they do not yet see. The question for us is: how does this work?

There are two key elements in any practice: the criteria for what counts as appropriate within that practice, and how the community that constitutes the practice defines what counts and holds people to account to the criteria of the practice. As Ford and Forman argue (2006), "In any academic discipline, the aim of the practice is to build knowledge, in other words, to decide what claims "count" as knowledge,

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[1] The results on the test were very poor as is to be expected given the context described above. The average percentage correct in the tests were as follows: Grade 3: 38%; Grade 4: 37%; Grade 5: 35%; Grade 6: 30%; Grade 7: 30%; Grade 8: 25%; Grade 9: 25%. In most cases, except for two or three items in each test, the majority of learners got the item incorrect.

distinguishing them from those that do not" (p. 3). Explicitly articulating what counts as knowledge means that boundaries are delineated (Bernstein, 2000), within which people can learn to act within the bounds of the practice and hence begin to gain access to the practice. Through using language in activity in practice, people communicate to each other what counts as that practice and hold each other to account. In other words, the construction of meaning happens symbolically in practice.

Across communities of mathematics teachers, there are different criteria for what counts as mathematics and as teaching. We know that internationally and in South Africa, many teachers work with a relatively narrow version of mathematics and teaching. This means that teachers have limited possibilities for appropriate action and it is difficult for them to imagine other possibilities. As Bourdieu (Bourdieu & Eagleton, 1994) points out, the symbolic constitution of our universe is "something you absorb like air, something you don't feel pressurized by, it is everywhere and nowhere and to escape from that is very difficult" (p. 270). This implies that unless there is something to disrupt taken-for-granted assumption in practice, our practices are extremely resistant to change.

In our project, the structured activities and artefacts support teachers to talk in and across differences in their taken-for-granted criteria, articulating what counts for them in relation to mathematics teaching and learning. In the process, their own criteria become objects for conversation and reflection for themselves and others, thus opening up new conditions of possibility for action. What is a key issue here is that the teachers account to each other through practices that are mathematical. As they analyse the test, map the test to the curriculum, plan and teach lessons and reflect on their lessons in public, they account for their actions in practice. In this way, the notion of accountability bridges the social and mathematical in that it positions teachers to both tell and listen to different views on mathematics. As teachers give accounts of their practices, they are able to distinguish commonalities and differences in their contexts that are different to what they imagined. Teachers talk about resources, the curriculum and their challenges with learners in ways that help them to see different ways of seeing. But most importantly, they talk about mathematics and are coming to see different ways to see learners through the mathematics of the curriculum.

MATHEMATICAL KNOWLEDGE

We start with Michael Young's (2008) notion that there is powerful knowledge, and that empowering learners means providing access to this knowledge. Mathematics as a discipline is identified as such powerful knowledge. While this knowledge is socially constructed, Young's argument goes beyond identifying mathematics as merely knowledge of the powerful, i.e. as a convenient filter to keep most people out of power, even though it is often used in this way. Rather he argues for a sociology of knowledge that understands how and why the structures of different kinds of knowledge provide more powerful ways of seeing and living in the world. Although

Young points to the structure of knowledge, he does not explain sufficiently what the power of this powerful knowledge is. What he does say is that powerful knowledge creates symbolic relationships, which support re-visioning the world from a more distanced perspective, thus providing a means of escape from Bourdieu's symbolic prison.

We have argued elsewhere (Slonimsky & Brodie, 2006) that developing powerful knowledge allows people to impose new grammars or orders of being on the world. This happens through two interacting processes: differentiation, which opens up established constructs making more textured understanding possible; and integration, which enables the construction of more powerful and economical concepts on the basis of what is previously seen as unrelated. So the process of learning is a transformation of relationships among current knowledge into ever more powerful, differentiated and integrated accounts of practice. We have shown previously, in relation to the curriculum mapping activity, that teachers have begun to see conceptual linkages between different parts of the curriculum they previously saw as distinct (integration), that they can distinguish different meanings for one assessment criterion rather than making a quick association it with a mathematical topic (differentiation), and that they are able to articulate points of alignment and misalignment between the official curriculum and their own teaching (Brodie, Shalem, Manson, & Sapire, 2008).

In the case of teacher knowledge and practice, differentiation and integration of practice occur in relation to what Bernstein (2000) calls the pedagogic device. The pedagogic device, which structures both the medium and the messages of schooling, consists of three message structures: distributive rules – which determine what is taught, i.e. the curriculum; recontextualising rules, which structure how teaching happens, i.e. pedagogy; and evaluative rules, which structure how what counts as learning and as knowledge are communicated. Evaluative rules are what make for accountability in practice. For Bernstein, evaluation coordinates the workings of distribution and recontextualising, thus condensing a range of messages through its most powerful message. Our program tries to help teachers to both differentiate the three message systems and bring them together through a focus on evaluation. We maintain our focus on evaluation through the use of the test, and also through a focus on learner errors.

LEARNER ERRORS

A focus on learner errors may seem strange. We have been asked why we do not focus on teaching goals and the strategies to reach them. Our focus on learner errors has one, obvious source. The results on the international test were very poor, as are the results on all comparative tests for South African learners. Making the test data available to the teachers immediately raises the question: why do our learners do so badly? While we aim to get away from the "shaming" that such results often produce, we do want teachers to seriously reflect on the fact that the vast majority of our learners are well-below grade level. But we want them to reflect on learners' performance in ways that do not blame learners or themselves and which provide ways for them to work with learner errors in order to transform them. We have shown elsewhere that this awareness is beginning to develop in relation to cognitive challenge and progression across the curriculum (Brodie, et al., 2008).

In terms of our argument above, errors are two-fold. On the one hand, labelling something an error invokes the criteria of the mathematical practice. On the other hand, errors are an important part of any practice, because they illuminate what mechanisms need to be put in place to give access to the practice. So errors point to the demands of the practice, while at the same time are the point of leverage for opening access to the practice. Errors give us a way to help teachers to see learners as reasoning and reasonable thinkers and the practice as reasoned and reasonable, and bring these two into a relationship. If teachers search for ways to understand why learners may have made errors, they may come to value their thinking and find ways to work it into classroom conversations. Errors are also a key area of evaluation for teachers – so talking about why learners make errors, and how teachers respond to these, brings together Bernstein's three message systems through a focus on evaluation.

A key theoretical understanding of our work is that learner errors are a normal part of the learning process (Smith, DiSessa, & Roschelle, 1993), are reasonable and make sense to the learners. Everyone makes errors in mathematics, even "good" students and teachers, and they provide for points of engagement with current knowledge. The constructivist view is that errors are produced by misconceptions (Confrey, 1990; Smith, et al., 1993), which make sense to learners in terms of their current conceptual structures.

One of the key characterisations of misconceptions (Confrey, 1990; Smith, et al., 1993) is that they are remarkably similar across a range of contexts and resistant to instruction, because they are so firmly part of the learners' conceptual structures. When the teachers worked together to analyse why significant numbers of learners may have chosen particular distractors on the tests, they were somewhat surprised to find that across schools in a diversity of contexts, their learners often make the same or similar errors. When the teachers discussed readings about common errors with the equal sign (how operational meanings of the equal sign, i.e. that the equal sign signifies "find the answer", interfere with the relational meaning of equivalence) they were able to further place their learners' difficulties in a broader context because learners the across the world share the same struggles. So these activities provide the teachers with a way to differentiate and integrate their own experience with those of their colleagues, both in the immediate context of the project and more broadly.

The readings about common errors with the equal sign also supported the teachers to articulate some of their implicit understandings of why learners struggle so much with the concept of equality and some of the many errors that they see in learners' work. For some teachers this was the equivalent of learning new mathematical knowledge, a subtlety of mathematics as a discipline that they had not understood previously. For others, this was an articulation of what they knew previously, in a nascent way. Thus reading the accounts of researchers in relation to their own practice, allowed these teachers to account more fully for their own practice and knowledge.

Errors also provide a useful focus because teachers orient towards errors in different ways. In more traditionally-oriented teaching, errors are either to be avoided or corrected, in the pursuit of correct mathematical knowledge. There are also concerns that a focus on learner errors suggests inappropriate evaluations and judgements about learners (hence preference for the term "alternate conceptions" rather than "misconceptions" in much of the literature). Thus errors might be avoided to prevent "shaming" of learners. Other reasons for avoiding a focus on learner errors is a fear that bringing them into the public realm will support a "spread" of errors among learners and create more obstacles and stumbling blocks, or that teachers will be distracted from their focus on their teaching goals and strategies (which often does happen). In more reform-oriented teaching, errors are to be embraced, as point of contact with learners' thinking, or as points of conversation to generate discussions about mathematical ideas. Thinking about their own responses to errors in developing lessons plans and reflecting on teaching, supports teachers to see how different systems of evaluation constrain and support different teaching approaches.

Yet another moment of possibility for more texture and nuance in teachers' thinking about their work relates to the role and responsibility of teachers in producing errors. An important point is that misconceptions are seldom taught directly by teachers. All learners develop them at some point, even in the most "reform-like" of classrooms (Ball, 1993; 1997). However, teachers sometimes exacerbate errors through "thoughtless", i.e. taken-for-granted use of language and concepts, and, at another level, through not making them public and dealing with them. At yet another level of complexity, a deeper understanding suggests that teachers cannot deal with errors quickly or easily because they are firmly held by learners and often resistant to instruction. So a focus on errors allows teachers to develop extremely nuanced understandings of the nature of mathematics, teaching and learning. Many teachers are starting to articulate some of these nuanced understandings to us in project sessions and as they speak to us about the project in interviews. We are also starting to see some of these understandings make their way into teachers' practices.

SOME INITIAL DATA

Although this is primarily a conceptual paper, we present some data here to illustrate our framework and indicate how data analysis will progress. In the lesson presentations, the teachers were asked to present two episodes: one where they dealt well with learner errors and one where they did not deal so well with a learner error. As an example of the first, a Grade 8 teacher presented an episode where he had acknowledged a learner contribution that was correct, but looked incorrect if learners were working with an operational conception of the equal sign. The learner wrote $2=x$ rather than $x=2$ and was greeted with shouts from his classmates that it was incorrect. The teacher calmed the class down and asked learners to justify their positions, as to why 2=x is correct or not. There was a short conversation where justifications for both views were discussed. In other words, the teacher asked learners to account for their criteria of what counted as an answer. After this the teacher explained why both are correct, i.e. he accounted for what counts for him and in mathematics.

In reflecting on the episode, the teacher told us that ordinarily he would have evaluated the answer 2=x as incorrect, and merely told the learners that they should write x=2. Given the work he had done in the project, he realised firstly that the learner was in fact correct, and secondly, that the learners who disagreed did so because they were working with an operational notion of the equal sign. So he was working with a more textured understanding of learner errors and how they might be evaluated. His conception of what counts as the meaning of the equal sign has opened, his conception of pedagogy has opened and his conception of learning and learners' meanings has opened. So his own conditions of possibility for practice as a mathematics teacher have been expanded. He was able to translate this understanding into a practice of working with the learners' ideas, giving them space to justify their thinking and then explaining why in fact both expressions were correct. So he could transform his understandings of learner errors into working with them in practice. Just as he has had to account for his meanings in practice in the project, so he supported his learners to do so.

It is notable that this was the only episode in this teacher's three lessons where the teacher was open to learner errors. In many other instances he ignored learner errors, or told the students that they were incorrect without listening to the reasoning behind the errors. But in trying to work with more textured shifts in teachers' practices, we need to acknowledge the small, but significant step that he did make.

A key part of our project is ongoing conversations about how criteria of practice and practices themselves are changing. When we asked this teacher why he was able to act differently in this instance, he said that as he was thinking about the learner's contribution, he looked up at the video camera and it reminded him about the project. While we all laughed at this comment, it is very significant. When he was back in his customary community of practice in his school and classroom, within the saturated atmosphere or symbolic "air" of the conditions of his usual practice and criteria, the video camera provided an interrupter, a mechanism to remind him of the project and his accountability to his colleagues. This reminds us, that the path from other-regulation to self-regulation in a community of practice is slow and uneven and contingent on ongoing accountability in practices in context. While teacher education may open up increasingly powerful and new possibilities for action, the next challenge is, as we have pointed out elsewhere (Slonimsky & Brodie, 2006), how to support teachers to make these changes in their customary communities of practices, so that these expanded criteria and resources of practice become a taken for granted part of the local community.

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