The discursive production of classroom mathematics.

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ABSTRACT: School mathematics is a function of its discursive environment where the language being used formats mathematical activity. The paper explores this theme through an extended example in which the conduct of mathematical teaching and learning is restricted by regulative educational policies. It considers how mathematics is discursively produced by student teachers within an employment-based model of teacher education in England where there is a low university input. It is argued that teacher reflections on mathematical learning and teaching within the course are patterned discursively in line with formal curriculum framings, assessment requirements and the local demands of their placement school. Both teachers and students are subject to regulative discourses that shape their actions and as a consequence this regulation influences the forms of mathematical activity that can take place. It is shown how university sessions can provide a limited critical platform from which to interrogate these restrictions and renegotiate them.

Keywords: mathematics, employment-based initial teacher education

Introduction

School mathematics is a function of the administrative constraints prevailing in the particular educational context. Teachers are typically obliged to follow curriculum guidance within such constraints in deciding how to teach, or otherwise meet the customary practices in their place of work. Meanwhile, their understandings of themselves are a function of the demands that they perceive being made on them. They may not, however, be fully aware of how their actions are shaped by their identifications with the discursive landscape. How then might we make sense of the mathematics that actually takes place in the classroom when it is enacted, perhaps unreliably, through the teachers' mediation of external demands? This paper addresses this question by considering some of the ways in which mathematics is discursively produced by student teachers working towards meeting the demands of externally produced definitions of practice.

This paper introduces an extended example in which a specific model of teacher education in England is considered in terms of how it generates understandings of teaching and learning mathematics. Prescriptive policies prevalent in that country for the last two decades have resulted in pressures on teachers to meet centralised criteria targeted on developing the practical skill needed to implement a detailed curriculum. This has led to some very specific interpretations of mathematics and its teaching. Teacher professional identity has been referenced to skill development within this frame and the

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wider assessment culture. The teacher's capacity to exercise professional autonomy has been shaped by these constraints. This scenario has been discussed in detail by Brown & McNamara (2011). For more than a decade now student teachers in England have typically spent much of their training period in schools. More recently, government-initiated "employment-based" models of teacher education have been introduced in which student teachers are located primarily in schools "learning from our best teachers" (DfE, 2010, p. 23). In this development they work in a paid professional capacity from the outset of their "training". These newer models co-exist with the mainstream established models. The paper discusses how student teachers participate in an employment-based model but references this discussion to wider conceptions of teacher education within the country. The purpose of this discussion for a wider audience is to consider how conceptions of learning and teaching mathematics change as a result of training being located primarily in schools. That is, it explores in this instance how mathematics is a function of the discursive environment in which it is encountered. The paper investigates how student teachers identify with particular discursive framings of mathematics teaching pertaining to this model of training. It asks how school mathematics is understood, empirically, for student teachers following this route into teaching. These issues are contemplated through the eyes of university teacher educators who are obliged to conceptualise their professional contribution from within a rather marginalised role. From this perspective, the paper provides a window on how teacher educators and student teachers variously conceptualise school mathematics and how these conceptualisations are influenced by multiple prescriptions, interventions and environmental constraints. It analyses the resultant conceptions of mathematics revealed by student teachers in their understanding of the challenges they face.

This attention to a specific example, however, is directed at opening a more general discussion in line with the remit of this Special Issue. That is, the paper addresses the much wider question of how school mathematics in any situation is a function of discursive parameters and how the language being used formats mathematical activity. The way in which mathematics is administered in the specific pedagogical environment determines what mathematics is. Having been determined in this way those conceptions of mathematics can police the practices that have been developed in the name of mathematics. Nevertheless, we shall consider how teachers can develop the capacity to engage critically with this discursive environment in their place of work and beyond through building reflective research within their practice.

The discursive shaping of mathematics education

Earlier work on the theme of mathematics education and language often addressed how mathematical language is spoken or written in everyday life, or more particularly within a classroom environment (e.g. Pimm 1987; Morgan 1998; Brown 2001). Later studies have taken a range of perspectives on how language filters or produces mathematical understanding. Barton (2007) has shown how mathematical meanings are a function of the specific language or culture. Another New Zealand study has looked at how computer media can be seen as impacting on the hermeneutic processing of mathematical ideas (Calder, 2012; Calder and Brown). Brown and Clarke (in press) conducted an international survey of how mathematical understanding is shaped by its institutional context. Much research has focused on how discursive formulations shape conceptions of

classroom practice and of the people working within them. For example, professional teacher identities are a function of how teachers understand themselves fitting in (deFreitas 2008; Walshaw 2008, 2010; Black, Mendick and Solomon 2009; Klein 2012; Reid, Brown and Smith, 2012). Conversely, Nolan (2012) asked how prospective secondary mathematics teachers were subject to official pedagogical discourses embedded in classrooms. Walshaw and Brown (2012) conceive subjectivity in terms of participation. Walls (2009) focused on children's subjectivities. Pertinent to the apprenticeship theme of this paper, discursive elements also underpin conceptions of identity centred on "legitimate peripheral participation" in "communities of practice", derived from the work of Lave and Wenger (1991). For example, Solomon (1998) examines mathematics as a community of practice and the teacher's role as epistemological authority in inducting pupils into such practices. Goos (2005) provided a sociocultural analysis of the development of pre-service and beginning teachers' pedagogical identities as users of technology. Watson and Winbourne (2008) edited a collection of work on this theme.

Pedagogical discourses also govern the choice of teaching devices, which in turn condition mathematical learning. For example, mathematical texts conceal conceptions of the pupils and teachers for whom they are created. Dowling (1998) showed how tasks designed for less able students in a teaching scheme were different to those given to more able peers. For any given topic the emphasis in instruction varied between the texts, resulting in exclusion for the less able from the real business of more abstract mathematical learning. Instead, they were caught in the discourse of "less able" mathematics characterised with associated styles of illustration, questioning and assumed perspectives. Meanwhile, Cooper and Dunne (1999) have shown how "realistically" contextualised test items designed for greater accessibility (and with a certain sort of pupil in mind) in fact produce greater class and gender differentiation. Working class children were less able to spot the "game" of school. Wagner (2012) considered how students are constructed in school texts, but also how the texts replicate teacher positioning and voice.

Brown and McNamara (2011) have considered student teachers as *subjects* in accounts of their own practices and how policy discourses were articulated through these accounts. The authors sought to understand how mathematics, pupils and teachers were shaped by policy initiatives and how they were included in the world depicted by the policy apparatus. For example, the government, rather than mathematicians or teachers, determined the constitution of mathematics within a legislated curriculum. Yet for Butler (1997, 2005) this very restrictive positioning as subjects creates a framework for resistance. "For what is it that enables a purposive and significant reconfiguration of cultural and political relations, if not a relation that can be turned against itself, reworked and resisted" (quoted by Davies 2005, p. 425). The more marginalised role for student teachers and their tutors can be re-crafted as a critical platform from which both tutors and trainees can inspect the stories governing their respective practices and the opportunities those stories provide for the development of analytical apparatus. As we shall see, however, given the brevity of the university sessions in question here this process is initiated rather than completed.

Background: Changes to mathematics teacher education in England

University mathematics teacher education in England has been redefined through new priorities determined by, among other things, budgetary constraint, problems with teacher supply (Rowlands and Ruthven 2011; Williams 2008) and perceived school performance as compared with other countries (DfE, 2010). The teacher education function has been re-distributed to include professional and subject mentors within the school setting (cf. Jones and Straker 2006). These mentors are themselves classroom teachers with their own classes to teach. This arrangement is thought to provide immediate opportunity for student teachers to develop classroom skills (DfE, 2010). The student teachers spend much less time at university with tutors, where they have some limited scope to reflect on their practice and to consider educational theory (Hodson, Smith and Brown 2011; Smith, Hodson and Brown in press). Plans are afoot to locate yet more "initial teacher training" in schools to further extend the current mainstream policy with implications for how mathematics is understood in classroom locations. "More than 11,800 trainee teachers are set to be trained by schools in 2012-13, the vast majority under a new programme called School Direct. The figure is double the 5,000-6,000 trainees taken on by schools in each of the previous three years under the Graduate Teacher Programme (GTP)[2] and other school-based schemes" (Maddern, 2012).

University teacher educators and school mentors, however, may have different priorities for their roles in teacher training (e.g. Price and Willet 2006), such as those relating to how mathematics is understood, meeting the demands of testing, effectively using materials, learning "a repertoire of pedagogical strategies" or building "personal mathematical involvement" (Watson and Barton 2011). There are different ways of understanding the disciplinary knowledge that teachers need (e.g. Askew 2008; Rowland 2008). Schools may prioritise the immediacy of classroom practice or following centralised guidance; universities may prioritise the more intellectually based elements such as subject knowledge, building professional autonomy, or meeting the demands of formal qualification (Hobson, Malderez and Tracey 2009; Jones and Straker 2006; McNally, Boreham, Cope and Stronach 2008; Hodson, Smith and Brown 2011). Some research, for example, has focused on the importance of teacher reflection in university settings and providing the resources for teachers to creatively generate mathematics in productive classroom exchanges (e.g. Brown and Coles 2012). Space for such activity has been greatly reduced. Hitherto, little research has been carried out on how increased school-based training supports the mathematical aspects of teacher education, and how they are conceptualised, prioritised and enacted, so that further interventions could be better informed. We know little about how new teachers understand mathematics following training across school and university settings (Rowland, **Turner, Thwaites and Huckstep** 2009); and, how student teachers conceptualise their own teaching of mathematics in schools.

Meanwhile, the government's high profile strategy of taking charge of school practices through a multitude of regulatory devices, such as through testing, prescriptive

2 The Graduate Teacher Programme is an example of an employment-based model of teacher education to be discussed in this paper. In this model of teacher education most of the student teacher's training is spent working in school in a paid capacity. Occasional days are spent at a university.

curriculum and school inspection (Askew, Hodgen, Hossain, and Bretscher 2010; Brown 2011) has resulted in mathematics and its teaching becoming understood through a culture of performativity (Pampaka, Williams, Hutcheson, Wake, Black, Davis and Hernandez-Martinez 2012). Most notably, the normative insistence of the [now nominally disbanded, but still heavily used] *Numeracy Framework* dictated in great detail how the teaching of mathematics *should* be conducted (Brown and McNamara 2011). This insistence has deflected attention from knowing how the re-distribution of mathematics teacher education has resulted in student teachers *actually* understanding and meeting the professional challenges they face. The removal of the *Framework* may eventually change how teachers and schools think about the learning of mathematics. Its very absence may change what mathematics in schools *is*.

These changing policies affect the challenges faced by teacher-educators and 'school mentors', and in turn influence student teachers' conceptions of mathematics and its teaching. The policies also impact on the identity of the student teachers. Are they *student teachers* engaged in an *educative* process? Or are they *trainees* fulfilling the requirements of *training* as specified by the government? University documentation also refers to *trainees,* yet being registered on a course they are called *students*. The new government standards refer to *teachers*, as they are common to trainees and qualified teachers. Within this paper we have chosen the designation *student teachers* or *students.* The children being taught will be called *pupils*. Bostock (2012) and Wall (forthcoming) have each discussed the conflict of designations when professional training meets academic

Method

The paper draws on empirical research carried out on two employment-based teacher education courses at our own university. One of the routes is for secondary mathematics specialists, with the other being for general primary teachers whose work includes teaching mathematics. The secondary student teachers would have completed a mathematically oriented degree of some description. The primary students would be graduates teaching mathematics as just one of several subjects, albeit a subject with high status. These students may lack mathematical knowledge beyond their 16+ examination, the minimal requirement for entry in to teaching. All student teachers are required to pass a mathematics skills test administered by a government agency.

For four successive academic years the authors, including members of the academic team managing and teaching the courses, have collected data through practitioner research. The longitudinal data collected within each year comprised examples of student reflections from regular recordings of university sessions, interviews, writing integral to course participation, assignments, correspondence between students and to tutors, reflective writing by the course team and interviews with students and with other staff responsible for mathematical content. Two extended interviews were held with tutors responsible for the mathematics element. Each session on each course included an element where progress was reviewed in terms of the changing ways in which the student teachers understood their professional challenge. These reviews incorporated regular reappraisals by the students of their own earlier writing as evidence of how they were changing.

Methodologically, we pursued a specific conception of "actor" within an action research model (Brown and Jones, 2001). Research was seen as active participation in wider cultural adjustments to new ways of being, in this case the move to different understandings of theory in new models of teacher education. A contemporary theory of the subject was introduced where the individual identifies with broader moves to new circumstances (Althusser/Foucault/Butler). These identifications produce changes in conceptions of the researched landscape and of the individual carrying out the research. Following Badiou (2009, 2011), knowledge was seen as relating to a particular state of knowing that prevails in a given set of circumstances. Yet, the imperative would be to constantly revise the narratives that guide our actions. Through living a story and becoming aware of its limitations we endeavour to change to a new story. Or rather, we endeavour to keep the story of who we are ongoing and alive, as we adjust to ever-new conditions. This methodological approach is discussed in more detail by Smith, Hodson and Brown (in press).

Thus the data collection was targeted on how theoretical aspects of teaching were progressively conceptualised by the students and how the course team responded to these emergent conceptualisations. That is, the research focused on how theory was understood empirically from alternative locations, rather than supposing that there was a correct version of theory to be attained. A key purpose of the course was seen as enabling student teachers to confront and challenge the narratives that bound their actions. Earlier work showed how conceptions of theory were reshaped according to the demands of the specific training site, where theory ultimately was aligned with the creation of analytical apparatus to meet the needs of generic capability across multiple sites (Hodson, Smith and Brown 2011).

The third and fourth years of the data collection further included a specific focus on mathematics seen as a particular case of our work on theory. In addition to individual interviews at later stages of the course in both years, nine secondary student teachers took part in a group meeting chaired by their university mathematics tutor, and eight primary students shared an extended discussion with the three members of the authorial team, which included the two course managers. These discussions were designed to review where the student teachers were up to in terms of their development as mathematics teachers on the programme and how the schools and the university had contributed variously to this. Analysis focused on how their understandings had changed. This involved sifting the interview transcripts to find instances of the student teachers' analytical connections to their teaching situations, such as evidence of their building an understanding what could work in schools generally rather than just in their current school placement. The earlier papers reported on such shifts and specifically on how students looked back on their earlier reflections on theory. This was less possible in any detail with the mathematics focus as the students were only in university for 8-10 days during their year's course with many demands being placed on their time. In the later interviews the intention was to capture conceptions of classroom mathematics, empirically, as it was being understood by the students at later stages of the course, but also through the recorded reflections of university staff either managing or teaching the course generally or specifically the mathematical elements. That is, echoing our work on theory, the research sought to avoid supposing that there was a correct version of school mathematics to which the teachers were supposed to subscribe. This paper is guided by

the more open research question: *How do student teachers discursively produce school mathematics?* In posing this question there was an assumption that the student teachers could work on the ways in which they conceptualised mathematics towards revising these conceptualisations. In addition to data providing insight for the research team, the student teachers themselves were able to look at past writing to consider how their conceptualisations had changed. By better understanding their own past conceptions of mathematics they would be able to move forwards.

This paper examines how teachers are *subject* to a specific model of teacher education to better understand how the assumptions implicit to this model are articulated through the teacher accounts of their practices. We shall attempt to show how this subjection restricts but also empowers the student teachers concerned. Individual and group interview data were analysed to assess the sources of influence or power referred to by the various parties and documents, and cultural models governing conceptions of practice: inspection procedures, the school apparatus, the curriculum (set to change), the former governmental *Numeracy Framework* (or new school schemes or textbook choices), teacher education models, professional development initiatives, the parents, the children, etc. Transcripts of interviews and student work were examined in relation to how identifications with mathematics were understood (Solomon 2008; Bibby 2009). This analysis looked for evidence of how the mathematics curriculum was being progressively reconceptualised and re-characterised (cf. Morgan 2006), in response to regulative apparatus (Brown et al. 2011), in relation to the wider curriculum (Alexander 2009) and to wider public conceptions of mathematics (e.g. Chap Sam 2002). The analysis sought to pinpoint how school-based training supported teacher subject knowledge. It further considered how university based teacher-educators conceptualised changes to their earlier ambitions consequential to greatly reduced contact with the students.

The paper draws on the analysis in addressing the research question. We now turn to how training for secondary and primary education produces the conceptions of school mathematics that govern teacher practice.

Student teacher experience of school mathematics

This section provides data on the mathematical aspects of the teacher education process. We take secondary and primary student teachers in turn with a view to highlighting how mathematics and its teaching are variously framed within the conceptions of their own professional practice in this area. In both cases our research strategies doubled as attempts to encourage the students to describe the worlds of their teaching, which so often would have been relatively private. The descriptions were seen in terms of making sense of their practice towards transforming that practice.

i) Secondary student mathematics teachers and university tutors

Issues relating to the university element were initially seen as peripheral ("*Reflective Account Two*? Whatever! It'll get done") or disdain ("It's paperwork…I hate X"). The dominant theme in discussions was the immediacy of practice ("The teaching's going fine - if I could just focus on that, it would be ok!"). It becomes clear, however, that the students feel that the teaching is not always "fine". In significant ways it is not fine and the discussions sought to dig deeper.

There was much talk about the vagaries of the assessment of the mathematics curriculum in relation to the performance of those taught. It is now increasingly common for those pupils taking public 16+ examinations to be entered early. Obtaining a prized pass at grade C[3] at this level was seen by some student teachers as introducing significant problems in subsequent pupil motivation and knowledge levels in the remainder of compulsory schooling in the subject:

> I've got the most bizarre class, a top set [16+] who have all passed [at C and above] and who've all got a different history. … [They] don't want to pay any attention at all to what's going on unless it's directly relevant to them. The theory is that they are an improvement class, trying to better their grade, so it's been really tough. I think it's a natural consequence of early entry and promising them all if they pass early, then they don't have to worry about maths anymore. Some of them have done it … purely on common sense and ability, in my view. They've turned up, done no work and got a C on the paper because it's pretty easy - don't know any of the higher [level] content and don't want to know it. Others have managed a B or an A … and covered a lot of it - got one or two gaps in order to improve. Deciding what strategy to do with them has been really tough. You can't do thirty different lessons can you?

Attempts by a university mathematics tutor to explain pupil behaviour as symptomatic of an assessment system driven by performance, rather than the intrinsic worth of learning, were not, at first, readily taken up by the students. That some pupils were differently motivated was acknowledged, however. The students themselves appeared to reduce the level of challenge that they faced personally in mathematics. One saw it as a need to "going back and remembering things", to reaching a solution to a pupil's (and their) immediate problem, rather than any inherent lack of understanding about teaching and learning on their part and a need to develop this. In arriving at a "quick fix" to the challenge faced in their learning, and nothing more, the students' behaviour seemed to mirror the behaviour they witnessed in their own pupils:

> 1/3 into 1/5ths? I don't understand it numerically - I *can* do it.

> I'm challenged ...whenever I teach [post 16+]. I'm always there and they're going, 'So is this right?' and I'm like, 'Ermmm - I'll just get a bit of paper'. But I try and do them beforehand, if I've got time, you know, work out all the answers myself and then I've got my work and I can go, 'Hang on a minute. Yeah, that's right'.

> I think it's a question of refreshing your memory sometimes. I've got histograms tomorrow and I think, 'How do these work?' And you just go through and … I remember.

> I find the [statistics] hard. When I was doing the [16+] stats, I thought, 'I'm going to have to teach myself how to do this.'

3 Grade C is widely recognised as the pass grade in national 16+ examinations.

> [Vectors]…they're *my* nemesis!

A second area of difficulty for the students related to a pragmatic and superficial approach of getting the mathematics lesson done, rather than teaching for learning. The lesson was easier when explicit teaching did not have to take place:

> I find it harder at the lower end…bottom set Yr 7 (11+). How do I know how to write pounds and pence…so much of it seems instinctive…I find that end more difficult.
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> You can take it [understanding] for granted [with the top sets].
>
> [The bottom sets] question it more – the top sets are just in kind of, in the mode of, we learn the method and do things. We do it for the exam, like little robots - quite happy. Whereas the bottom sets can't do it that way. They want to know why it is and they don't understand what's going on and they're mixing up different things they can remember.
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> Some [pupils] just understand it without you delving into it. Some [pupils] discover it for themselves …and some don't and they're the ones who get it wrong and that's why they don't get it. Even if you try to drill them, because they don't understand it, they're not going to remember it…what about the ones who've never discovered it? We teach those that already understand it and knew it and they practice it, and they do well. And I think my challenge is how to move some [pupils] on who didn't understand it first time, who haven't got their head round it. How do you move them on?

Some of the student teachers recalled helpful materials issued by the university, which delved into such topics as pupil misconceptions, strategy games and "scripted lessons". However, one of them talked of being "swamped by other (training) agendas" as an excuse for not referring to the materials as much as she would have liked. Now spurred to "get underneath what the maths is about", during a group interview a tutor asked some students how they decided what mathematics they would teach and how they would teach it. In responding, the students became very animated. The slavish adherence to textbooks was contrasted with the supposed liberty of following a scheme of work. In reality, however, there was little to support them in either in their quest to teach mathematics in ways that might encourage interest and understanding:

> At my school it's just a textbook basically you're working through the textbook and do X number of chapters per half term. My head of department is really hung up on it. It drives me mad. The other day I was doing something a bit different and then he's going, 'You can't do the end of chapter tests on that because you haven't done exercise 5b [in the textbook]!' I feel as though he wants me to do every single question in the textbook.
>
> Literally you follow page after page …and you just did it in order of the textbook … These are our schemes of work written up by the head of department for Yr 7 (11+). It

> tells us what topic we are doing, when …what they should be doing, what are the key words. We sign up to an APP [*Assessing Pupils' Progress*] programme[4], which we can use if we want to … All our kids will start a lesson with this. They'll identify stuff they can already do …what they have to do to get to [National Curriculum] level 5[5]. I will plan my lesson, I use the scheme of work and I do this by myself. I don't have anyone to tell me what to do - no one checks that. There's no textbook to follow. I just teach my lessons so that they can do that, can use these words. At the end of topic, they have to do the APP at the end of that.

ii) Primary mathematics student teachers and university tutors

Towards the close of a group interview, some primary student teachers were prompted about the extent to which assessment was an issue in their development as teachers. Unlike their secondary peers, they had neither introduced nor, as we are to see perhaps, spoken about a dilemma concerning performativity in tests and external assessments; at least not on the surface. Some more persistent primary voices showed, however, their developing sense of skill in assessment practice and the multiple filters through which it needed to be understood.

> I find assessment quite difficult sometimes … For example, if I'm doing "direction" with the lower ability [pupils] that might be my [National Curriculum level] 2bs or 2cs. They just need to know a quarter turn and a half turn, whereas the higher ability need to know quarter, half-turns and three-quarter turns as well as clockwise and anticlockwise. ... Sometimes I'll come to the assessment sheet and there'll be nothing in there for whatever it might be and that's when I get flummoxed with it… Am I doing the right thing here? … Sometimes you won't find it … It just won't be there … I never really thought that in first half of the year. I just was differentiating because I knew 'that was harder'.

At the group meeting the primary student teachers were pressed directly about whether performance identified in the secondary discussion was indeed an issue for them. About a third of the group talked about overhearing the Year 6 (10+) colleagues in conversation about things "coming up on the test". Tests were held for pupils at the end of their primary schooling. Some felt that assessment was much more relaxed for the learners in a

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4 *Assessing Pupils' Progress* (APP), administered by the government's *Qualifications and Curriculum Development Agency*, has been developed for optional use in schools in England and Wales to enable teachers to assess pupils' work consistently across both the secondary and primary National Curriculum. Many school shave abandoned this scheme as a result of its excessive demands.

5 Pupils would start their primary schooling at Level One and transfer to secondary school at 11+ where the average level would be 4, but where pupils would be spread over a range typically between levels 3-6. Formal tests take place for children aged 7+ and 10+ where the later test results are published. There are informal tests at the end of each primary school year referenced to National Curriculum levels.

primary setting with no real "pushing" of performance. Seven year olds often remained unaware of the interim tests that they completed. Others felt that the extent of accountability was dependent on the ethos of the particular school. In one school it was normal to maximise levels of performance, "as soon as a piece of work was finished, wham, it was levelled" [according to National Curriculum level]. It was enough to maintain a standard in a second school. Most student teachers recognised a key difference between their own experiences of assessment and that of the secondary student teachers. For a higher proportion of primary student teachers, the presence of National Curriculum levels was a continual process, "formative" rather than summative, as was the case for most secondary student teachers with their focus on tests and exams. The primary students agreed that this led to an on-going pressure to monitor progress, and not simply react at the end of the year. Nevertheless, as the discussion continued it gradually became clear that these students were developing an awareness of the spectre of accountability haunting their teaching. Mention was made of the "expected 2 sub-levels of progress" (e.g. moving from National Curriculum Level 2c to 2a) learners were expected to make in the year, and an awareness that if this was not the case, "you're [the student] going to be questioned". The students voiced their growing concerns about perceived lack of progress, "why is this cohort not scoring is constantly in your mind" others spoke of the impact of children being inaccurately assessed by colleagues, claiming, "it'll look as though I've taken them backwards".

Interestingly, one primary student teacher wanted to address children's understanding of concepts and distanced himself from governmental expectations graded as successive "points", which he saw as unattainable for children in his setting:

> They're expected to get Point 9[6] by the end of [4+]. We have kids who are on Point 2 or 1. They're not going to get to a Point 9 and if we have two or three children on Point 9 at the end of the year then that's average. ... We have interventions … in place for the highers [higher ability pupils] and the middles and the lowers …There's only so many of us…90 kids and three teachers … It's often the Teaching Assistants[7] who deliver the interventions and they often haven't had the training... It is in our interest to raise our understanding and keep this in mind but I almost think it's an impossible job, impossible to get to expectations... If [government inspectors come, they are] not interested in why. They wouldn't take that into account.

Reflecting on the primary student teachers' discussion, one of the tutors made the following supporting observation:

> They are not making the connection between the children's very closely targeted learning and the assessment processes that are informing and driving this quest. Levels and targets have just become part of their professional dialogue. They are not asking what makes a child [National Curriculum] Level 2a and how the teacher knows that it

6 This refers to an assessment tool used with children aged from 3 to 5 years.

7 Teaching Assistants are commonly employed in English schools alongside the main classroom teacher.

> is reasonable for that learner to have progressed to Level 2c by the end of the year. They operate currently by planning lessons that allow children to progress with their individual targets without knowing clearly where these came from or where they go to, just that's what they are required to do. So like the goldfish in the bowl being unaware of the water, they are unaware of the assessment driven process. It just is.

It would seem that the student teachers are not always aware of how the regulative discourses were *shaping* their practices. As with their secondary peers, however, primary students were very aware of the policies and associated apparatus *validating* their practice. This was more vivid when the student teachers talked about applying the teaching methods preferred by the school, or those featured in the *Framework*, such as in following calculation methods different to those encountered by the students in their own schooling.

> Putting myself in the place of the child is difficult. ... The way that I would work it out is slightly different. ... I am having to constantly address my own way of dealing with these problems. We have a policy, certainly for the four rules [of arithmetic]...
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> I was doing ratio... and they were coming up with methods and I was looking at the class teacher asking 'shall we go down this route?'

Clearly some students felt constrained about following the children's line of enquiry for fear of wasting time, or far worse, confusing learners by moving away from agreed models. However, mathematics was obviously a subject where they had to actively stand at the front of the class and teach, rather than simply respond to students' individual work:

> That would be my main teaching I'd say here's one method of long division or accounting method, here's one way of doing it, did everyone get the same answer did anyone get it in a different way.
>
> I've taught [primary maths] and never seen children working out of books and teachers responding. There's an oral starter then shared input, paired or group work then independent work. And it's that shared input is the essential bit for you … to see the differentiation in the class if it's working or if someone needs to move group … Luckily in first term I was in the Maths co-ordinator's[8] class. She would use three different types of input… to meet the needs of different learners... It was amazing to watch, very hard to do.

Some students, however, did describe points where children were deemed to have reached a point where they could choose their own mathematical processes in an assessment activity where they were told "If you want to use the number line … use

8 Mathematics coordinators are teachers in primary schools overseeing mathematics teaching throughout the school.

which methods you want to ... there were no restrictions ... which really helped me to see what the children could do". However this student then asked his mentor "is this [method] valid?" and was reassured, "If they got there, we'd probably support that".

There was an emphasis on the *how* of teaching in each phase. The school scheme was a key part of this. There was, however, room for flexibility depending on the needs of learners, teaching and learning policy. Calculation and method played much larger roles in the regulation of primary students' working practice.

Discussion of data

We have sought to give some insight into the varied ways in which the student teachers map out the territory of their practice. How do they talk about the world that they inhabit? Which points of reference are mentioned most? How are those points of reference probed within the research orientation of the course? The scene depicted is dominated by an ever-present culture of assessment. The teaching of secondary students was a step-by-step targeting of 16+ ambitions. Primary students followed textbooks and schemes where the assessment levels were built in to the "goldfish bowl" of their practice. We have spared the international reader much of the jargon; of "levels", "key stages", "points", that dominated student accounts to avoid those details from distracting attention away from our more general concerns. Yet the terminology did much to partition mathematics according to discrete learning objectives. Mathematics is defined by alignment with a criterion-referenced listing shaped by the demands of this assessment. Meanwhile, the university element had become quite restrictive as a consequence of its brevity. Familiar features in many models of mathematics teacher education had become marginalised through demands for compliance with current practices in schools. In the reality of the training experience for many teachers in England explicit space for developing the intellectual dimensions of practice has become much reduced. The teacher's conception of his or her own professional identity is tightly referenced to the regulative structure set out in policy documents. Teaching is seen as the meeting of assessment targets expressed in those terms. Success in teaching is referenced to the existing model in schools whose achievements had so dissatisfied the government prior to the reforms.

To summarise key issues raised in the data one might highlight:

a) *Performance driven assessment affects the nature of mathematics.*

By emphasising the elements that are more likely to be tested mathematics is diminished. Current conceptions of school mathematics are supported but only in a narrow way. Less emphasis is placed on pupils being able to adjust to future demands. This emphasis drives compliance to external demands in which student teachers and their pupils play a smaller part in the construction of mathematics. There is a culture of "getting it done" or "giving the method" rather than teaching for understanding: "Does that make sense… is that realistic?" An occasional decision to "step back" from the formal in the name of building understanding, "light bulbs were going on everywhere", was seen as an exception rather than the norm. There is a C grade discourse of mathematics and an A* [top] grade form that are sometimes seen as incommensurable, rather akin to the division identified by Dowling above. Such partitioning happens throughout primary and secondary schooling. Being a teacher is understood in terms of shaping mathematical activity to meet the

required forms to suit the given class composition. This has led to some issues of continuity in education in England where 16+, 18+ and university degree level mathematics each work to a different discursive frame as to how teachers, students and mathematics are each understood. Similarly, the less able were seen as needing to be taught rather than the more able who could "discover" more for themselves.

b) *School based training can nurture narrow administrative conceptions of teaching.*
The schools' insistence on following specific textbooks "page after page" in some instances diverted students from trying out ideas introduced in university sessions. This administrative insistence on a clearly defined but narrow route resulted in an antipathy to risk. This is perhaps unsurprising for primary students who have usually not gone beyond their 16+ examinations in mathematics. Yet even for secondary teachers with formal mathematics backgrounds there was some trepidation in relation to the mathematical demands of teaching. The assessment driven conception of mathematics had also prevailed in the students' own school education. They had learnt mathematics to pass an exam, not for understanding (Pampaka, et al., op cit). It was however felt that school-produced schemes provided more scope for teacher creativity. Also, some students felt sufficiently supported by schools and were able to experiment to reach better understandings about what counted in their mathematical teaching and learning.

Yet this occasionally negative assessment of apprenticeship based training limiting mathematical teaching is countered by some additional pedagogical factors that were seen by some mentors, tutors and students as conferring some benefit:

c) *Practice-centred learning can improve participation in schools*
Some school practitioners interviewed saw virtue in employment-based models because of their immediate concern with the demands of the classroom. A mentor responsible for overseeing such students in a demanding inner city location spoke of how the school's greater input allowed more investment of support time aimed at enabling new teachers to survive and function in difficult circumstances. For a school with a well-developed scheme of work, student teachers and pupils alike may benefit from the student working to a clearly defined structure as a shared enterprise with colleagues. Such a *community of practice* may supply genuine opportunity for students to experience an insider perspective on being a teacher. As one student put it: "the behaviour of the students is challenging, but we're encouraged to take risks and try out activities". A number of students in our sample were offered jobs by their placement schools prior to the course being completed. This was good for the school to have found a suitable teacher in an area of persistent teacher supply issues, but could reduce the student's motivation to exceed the already limited academic demands.

d) *Benefits for university-based tutors through shifting their perspective*
Benefits for university-based tutors were achieved through a more circuitous route. In previous models of training the university had been responsible for introducing the National Curriculum and the associated guidance that was still in force. This approach generated a substantial checklist of competencies and criteria to be addressed. The erosion of time in university reduced this dimension of university input, and the remnants

were subject to ever more compression. The university tutors initially experienced this erosion of time as an intensive working life where time with students comprised a frantic rush through the requirements. Conversely, however, the students found their time in university to be a respite from the intensity of their school-based work. In due course the university sessions focused more on response to and initiation of classroom-based research in support of the students' immediate practice. The university objectives shifted from being list of competencies, now transferred to the placement school's remit, to being that of supporting students in developing a more holistic engagement with their school-based experiences.

e) *The enforcement of a centralised curriculum supports a collective vision of learning*
The motivation behind the somewhat insistent centralised curriculum was centred in administrating the many teachers who lacked the mathematical skill and professional capabilities to work without explicit support towards a collective set of ambitions. Any collective arrangement requires compromise and unnecessary guidance to those teachers who were adequately skilled was seemingly a low price to pay for wider participation in a shared arrangement. Mathematics education research is sometimes predicated on finding more refined pedagogical strategies for a teacher to follow whilst neglecting the reality of teacher recruitment in terms of individual skill. This paper has sought to better understand how student teachers might creatively identify with approaches spanning a larger population of teachers as a mode of support for those with lower confidence or specialist background.

f) *Research is directly focused on developing practice*
Many instances of mathematics education research are finely tuned on issues unlikely to be encountered in training courses. Students typically did not encounter expositions on the knowledge of mathematics education research. Within the apprenticeship model described, however, the students themselves were participating in forms of practitioner-oriented research made possible by the immediacy of on going school practice. The university element that had often been seen as irrelevant by many students in the first instance later became an effective critical platform for inspecting and reflecting on their own school practices. This platform comprised an opportunity to articulate the shaping of practice from an alternative location in which everyday demands could be understood against a wider context. Rather than thinking what would work in the current placement *school*, the concern became that of thinking more broadly about what would work for them across *schools* more generally. So rather than student teachers being subservient to a map dictating the format of their practices, they had some influence over how the map was created and how it could be seen as guiding their generic practices as a teacher.

Conclusion
School mathematics is a function of the educational domain in which it is encountered, and hence of the discourse that characterises that domain. That discursive structure can shape the actions of those subject to it yet it may be possible to step outside. This paper has documented some instances of mathematics teaching practice resulting from modified conceptions of teacher education. The teachers' conceptions of mathematics developed

without a great deal of explicit instruction from university specialists in the area. Rather the teacher education function was achieved through the student teachers being immersed in the infrastructure of schooling. In the approach described, the student teachers were primarily guided by their school mentors through centralised curriculum documentation, or by textbooks chosen by head teachers. That is, the students' mathematical pedagogical knowledge is derived from their own practice referenced to existing or required conceptions of mathematical knowledge and patterned on the associated apparatus. Their way of talking about mathematics teaching mirrored the official discourse. As a consequence there is a strong reproductive dimension to the student teachers' understanding of school mathematics. Mathematics is defined within very tight boundaries that give it little space to be something else, such as mathematisations generated by the teachers or pupils themselves.

Specifically, in the data presented, mathematics derives from particular types of encounter in a model of teacher education.

On the one hand, mathematics is understood in terms of fixed results, levels and following procedures. Little opportunity is provided for the student teacher to develop an autonomous professional attitude to the generation of mathematics in the classroom. Rather, the students are *subject* to an externally imposed curriculum as represented by the mentors to whom they are assigned. They understand their own professionalism and identities in those terms. The goldfish bowl of practice denies some space to a more externally critical attitude in favour of training through immersion in school. Although there has been some stepping back from the more prescriptive aspects of the curriculum guidance, the student teachers are still subject to a legacy in which conceptions of teacher have little room for manoeuvre, predicated as these conceptions are on specific constructions of mathematics. Some students, however, feel more secure with these arrangements in an area where they may lack confidence. Their own mathematics background may also have been centred on test performance rather than on understanding limiting their capacity to step away from pre-defined pedagogical routes. Such students needed to know the topic in advance as defined by the particular book or scheme rather than treat the encounter as a process of shared learning.

On the other hand we have shown how the new model does provide an avenue through which student teachers and their tutors can experience the teaching of mathematics from new angles. This dimension however is at risk as yet more teacher education is scheduled to take place outside of university settings. In the model described student teachers retained some possibility of inspecting their practices in school from an external site so that their insider experience of meeting immediate demands can be reviewed against a more holistic understanding of what they are trying to achieve. University tutors meanwhile, provided a responsive role in helping students to confront demanding classroom challenges in more creative ways, albeit in terms of administering mathematics to the prevailing model.

This paper has focused on specific themes pertinent to the situation in England where school based training is legislated as the norm. As seen, the government has indicated its preference for expanding this type of provision. Indeed, school based teacher education can be developed to provide supported participation in communities of practice where mathematics and its teaching are built as more collective enterprises shaped around the needs of mainstream schooling arrangements. This however would be an unpopular move

in some quarters. The point of this article, however, is not to invite international readers to try this at home. The more general issue relates to how mathematics teacher education knowledge is conceptualised and how this shapes practice. We have argued that the students' conceptions of mathematics and its teaching on the course described are crafted around the apparatus of administrative control, which are restrictive, expressed in terms of curricula compliance, or fitting in with existing school practices. This administrative restrictiveness in the name of policy implementation is potentially counter both to pupils achieving a positive disposition towards mathematics and functionality in the subject in later study or professional life (see Pampaka, et al. op cit.). These conceptions also diminish the teacher's professional life, reduced as they are to following someone else's model during their formative years as a teacher, where experience across different placement schools is uneven.

Yet in the model described, research carried out by student teachers fuelled a more generative attitude to practice that could be supported and developed in university sessions. That is, a practitioner-oriented reflective approach comprised an integral dimension to practice in school and the university sessions. Here, research is not seen as knowledge confirming a desired state of affairs in the manner of yet more insistent external demand. In the approach described, the university, rather than being the font of knowledge depicting models of good practice, provided a critical platform from where analytical apparatus could be created to support the generation of knowledge in developing practice, to counter excessive compliance with those external demands. The demands may shape our practice but perhaps we can develop the capacity to distance ourselves from the discursive parameters that deliver those demands. As Butler (1997) puts it: "Subjection consists precisely in this fundamental dependency on a discourse we never chose but that, paradoxically, initiates and sustains our agency" (p. 2). "Power not only *acts on* a subject but …*enacts* the subject into being" (p. 6, her emphasis). That is, the discursive arrangements that define practice can be inspected from outside and then turned against themselves to provide leverage into a new space.

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