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Experiencing mathematics classes: ability grouping, gender and the selective development of participative identities

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Abstract
Mathematics education reform emphasizes the need to move away from transmission models of teaching to discursive classroom practices in which students negotiate and justify solutions to problems. This shift has potential, but not inevitable, implications for students' mathematical identities with respect to their sense of ownership and participation in mathematics as a creative activity, and is particularly pertinent in the UK context in which ability grouping and its associated pedagogic differences is prevalent. This paper presents an analysis of 13-15-year-old British pupils' accounts of learning and doing mathematics, and shows that the pedagogic practices of ability grouping do indeed have a major part to play in the development of participatory identities for some pupils but not for others. However, the data also show that learning is more than participation: it is also dependent on the discursive positions that individual pupils take up. The paper theorises further about the role of self-positioning in the development of individual mathematics identity trajectories.

1. Introduction

We have been aware for some time of the effect of ability grouping on learners' perceptions and expectations of themselves and on the type of teaching and relationships with teachers that they have (see, for example, Ball 1981). In a recent paper, Wiliam and Bartholomew (2004) report on the impact of ability grouping on pupil progress in secondary school mathematics and once again link this to the type of teaching which they experience. Like many mathematics educators, Wiliam and Bartholomew are concerned that this practice depresses rather than raises performance for pupils who are not in the higher ability groups, and frequently results in teaching which is narrow in approach and untailored to individual student needs – the opposite of the kind of teaching advocated by mathematics education reform. This paper is situated within a broad CHAT perspective and begins by blending a neo-Vygotskian focus on language and interaction with the insights on identity provided by communities of practice approaches to explore the links between ability grouping and attainment in terms of differential access to knowledge and knowledge-making and the development of identities of participation and non-participation. An examination of pupils' accounts of learning indicates however that in order to understand the construction of particular identities for particular learners, we also need to recognise the role of dominant discourses of gender and ability in the ways in which boys and girls are positioned, and position themselves, in mathematics classrooms.

2. Theorizing developing identities in the classroom community of practice

Wiliam and Bartholomew's (2004) analysis of ability grouping ('setting' in the UK), teaching styles and examination performance in mathematics in six schools leads them to conclude that 'the most pernicious effects of setting may not be necessary consequences of grouping students by ability, but appear when teachers use traditional, teacher-directed whole-class teaching' (p.289). Although all students in top sets made greater progress than those in lower sets, the discrepancy in progress was greatest in those schools which used whole class teaching. In these schools, Standard Attainment Tests (SATs) performance in Year 9 (age 13-14) did not predict General Certificate of Secondary Education (GCSE) performance in

Year 11 (age 15-16) whereas ability group did. In contrast, in schools using predominantly small group or individualised teaching, top ability groups did not perform significantly better at GCSE in comparison with pupils in lower groups when SATs attainment was controlled for. Although these findings are not unusual in that they are in line with previous research concerning ability groups and attainment in mathematics (Boaler et al., 2000, Ireson et al., 2002) they do raise the question of exactly why teaching style should make a difference in this way.

An initial answer to this question underpins much U.S. and European mathematics education reform, which seeks, essentially, to 'promote meaningful learning' (Nathan and Knuth, 2003: 175). Building on broadly constructivist approaches, critics of traditional mathematics teaching emphasise the role of the classroom community in supporting students' learning via conjecture, experiment, argument and justification (Ball, 1993; Bauersfeld, 1995; Cobb, Yackel & Wood,1993; Lampert, 1990; NCTM, 2000; Steinbring, 2005; Williams and Baxter, 1996). This characterisation of mathematics brings with it an emphasis on the role of classroom interaction in learning and the teacher's role in it, underlined by the NCTM's (1991) *Professional Standards for Teaching Mathematics* as 'eliciting and engaging children's thinking; listening carefully; monitoring classroom conversations and deciding when to step in and when to step aside' (Nathan and Knuth, 2003: 176). Supporting this kind of learning is often a question of fostering discussion between pupils, enabling exploration, and assisting learners in formulating their ideas in a mathematical way. However, as a number of researchers point out, creating the classroom environment in which this can happen is more easily said than done. There are various issues to be negotiated in the development of good practice defined in this way, including teacher beliefs, prior experience and institutional practices such as ability grouping (in the U.S., Nathan and Knuth, 2003, and in the UK, Ireson & Hallam, 2001), the legacy of a very different teacher training (Ross, 1998), the absence of specific guidance in reform pedagogy (Ball, 1993) and indeed the development of teachers' own identities (Van Zoest & Bohl, 2005; van Zoest, Ziebarth, & Breyfogle, 2002). There are deeper issues than this, however: understanding learning as participation also involves examining 'how learners interpret and act on their worlds' (Edwards, 2005a, p. 59). Pupils too have a part to play: as the narratives discussed in this paper show, they bring their own personal mathematics histories, values and assumptions with them to the classroom – thus, as Lemke (2000:278) points out, teachers and students together create a classroom culture which is both unique and typical:

> A classroom … is an individual at its own scale of organization. It has a unique historical trajectory, a unique development through time. But like every such individual on every scale, it is also in some respects typical of its kind. That typicality reflects its participation in still larger-scale, longer-term, more slowly changing processes that shape not only its development but also that of others of its type.

2.1 The guided construction of knowledge: Neo-Vygotskian analysis

One aspect of such typicality is the shape of pedagogic interactions themselves. These, and their relationship to the construction of knowledge on the micro-level are captured well within Neo-Vygotskian analyses of classroom discourse, enabling us to see how differential access to that knowledge can come about. So for example, Edwards and Mercer's (1987) identification of culturally-based and largely implicit ground rules of educational discourse which underpin the smooth running of classrooms shows how teachers are able to control the topic of discussion and how it is to be talked about, superimposing onto classroom experiences the particular words and meanings that are the target of the lesson, and so delineating the nature and shape of the knowledge which is constructed within it. Their account of the 'guided construction' of knowledge presents a detailed analysis of how classroom discourse works to build an understanding of new concepts via a collection of linguistic devices used by the teacher: responses which confirm, reject, repeat, elaborate, reformulate, paraphrase or reconstruct pupil contributions, references to implicit, presupposed and 'joint' knowledge, clues of gesture and intonation to denote significance and so on.

For these linguistic devices to successfully guide and develop pupils' understanding, a teacher also has to establish a joint frame of reference with them, making use of shared prior knowledge, and appropriating, modifying and feeding back pupils' ideas (Mercer, 1994). Thus Edwards & Mercer (1987: 62-3) describe education as

> a communicative process that consists largely in the growth of shared mental contexts and terms of reference through which the various discourses of education (the various 'subjects' and their associated academic abilities) come to be intelligible to those who use them.

However, its success depends crucially on the establishment of these shared frames of reference. Without them, teacher-pupil interaction can work in a rather negative direction to foster merely ritual or procedural knowledge which is 'embedded in the paraphernalia of the lesson, without any grasp of what it was all really about' (p.99), as opposed to principled, transferable knowledge – 'understanding the issues and concepts, and their relationship to the activities' (ibid.). Edwards and Mercer's analysis, followed by Mercer's later work (Mercer, 1995, Mercer, 2000), that of the National Oracy Project (Norman, 1992) and work such as Black's analysis of primary school mathematics (Black, 2004a, b) suggests that in the cultural context of the school, the power imbalance between teachers and pupils and the pressure of school performance measures mean that shared frames of reference are frequently sacrificed as discussion is abandoned or quashed and opportunities for appropriating prior pupil knowledge are missed. Thus pupils frequently merely guess what teachers want them to say in response to their many questions rather than genuinely engaging with them, with resultant detrimental effects on their understanding (Dillon, 1990; Myhill & Dunkin, 2005; Wood, 1992). This phenomenon, while common, has been recently reported on with respect to mathematics teaching in the U.K. with some dismay (OFSTED, 2006:2-3), linking low achievement and participation with 'Teaching which presents mathematics as a collection of arbitrary rules and procedures, allied to a narrow range of learning activities in lessons which do not engage students in real mathematical thinking…[and] a narrow focus on meeting examination requirements by 'teaching to the test', so that although students are able to pass the examinations they are not able to apply their knowledge independently to new contexts, and they are not well prepared for further study'.

The neo-Vygotskian literature suggests a cluster of resolutions to this problem in terms of the redistribution of power in the classroom. One approach is to encourage pupils to discuss topics in small groups, so increasing their group performance and even individual understanding (see for example Barnes & Todd, 1995; Mercer, Wegerif and Dawes, 1999). Another is to focus on the importance of working within the individual pupil's zone of proximal development: individualized teaching in terms of scaffolding (or assisted performance in Tharp and Gallimore's (1991) account) enables recognition not only of the status of a pupil's understanding and consequent matching of tasks and teaching, but also an appreciation of their individual expertise (Wells, 1992). A corresponding shift which aims to avoid the difficulties of working within the ZPD with many learners in the same classroom is that advocated by Mercer & Fisher (1998) of fostering a "community of inquiry" (see also Mercer, 2000). This body of work provides an initial answer to the question as to why the effect of type of teaching in mathematics observed by Wiliam and Bartholomew should make a difference in terms of students' access to mathematical understanding. However, there are still questions to ask: how and why does teaching differ from group to group, or even within the same group of pupils – as Black (2004a) observed, some pupils but not others appear to share a mental context with the teacher and are hence involved in more productive talk. How can we explain individual differences in engagement over time, and what are the long term effects of differential access to shared mental context?

2.2 Identity in a community of practice

A way forward is suggested by Wenger's (1998, p.151) definition of identity as 'a layering of events of participation and reification by which our experience and its social interpretation inform each other. As we encounter our effects on the world and develop our relations with others, these layers build upon each other to produce our identity as a very complex interweaving of participative experience and reificative projections'. Identity is therefore cumulative: it is built over time as we participate (or not) in a community of practice, and the nature of our participation and our location of ourselves is interpreted in terms of the values, assumptions and rules of engagement and communication of the practice. This appears to fit educational experience very well – a learner's actions in the classroom are interpreted and those interpretations in turn influence further actions within a network of relationships which include teachers and pupils. Identity in this sense is not fixed, of course, and individuals move in and out of practices on a number of trajectories, sometimes as a peripheral participant on the way to full participation, sometimes as an insider participating in the evolution of a practice, sometimes as one who spans the boundaries between practices, and sometimes on the way *out* of a practice (pp.154-5). Thus Wenger suggests more than one 'mode of belonging': identity has multiple aspects of imagination, alignment and engagement.

Engagement in a practice is characterised by active negotiation of meaning within it – our appropriation of those meanings is what enables an identity of participation (p.202). It represents an embeddedness within the practice and from that point of view may be seen as an ideal in education terms. However, imagination as a mode of belonging involves standing back from direct engagement and an awareness of actions as part of historical patterns and potential future developments, of others' perspectives and of other possible meanings. It is 'a process of expanding our self by transcending our time and space and creating new images of the world and ourselves' (p.176) and so involves a positioning of self with respect to our own and other practices. Importantly, it enables an identity of learner. In contrast, alignment emphasizes common patterns of action: we position ourselves through adherence to global practices and identify ourselves in accordance with them. Thus these three modes of belonging are complementary, and indeed Wenger argues that 'they work best in combination' (p.187).

However, each has trade-offs. The most important for my current purpose concerns alignment: although alignment is important in maintaining a practice, an identity of non-participation can be generated by demands for alignment when the ownership of meaning is not shared: while initial guidance and modelling introduces the learner to the possibilities of a practice, lack of ownership generates and is generated by compliance and an emphasis on procedures (p.205). Thus we can see a source for Edwards and Mercer's (1987) 'ritual knowledge' as a product of teaching in which learners have no control and simply seek to supply teachers with 'right answers' in a context which 'does not require the complex processes of negotiation by which ownership of meaning can be shared [and] which results in an inability to adapt to new circumstances, a lack of flexibility, and a propensity to breakdowns' (Wenger, 1998:206). Even when negotiation is possible in a classroom community, we can see that some students may have less access to the construction of knowledge, since they may be excluded from processes of mutual engagement. These students may of course be those who have less access to the discourse of the classroom, and hence are those whose non-participation becomes marginality: thus Wenger suggests that 'members whose contributions are never adopted develop an identity of non-participation that progressively marginalizes them' (p.203) - we need an ongoing identity of participation in order to learn.

2.3 Identity and the mathematics learner

A range of research shows that identity does indeed play a significant role in pupils' beliefs about themselves as mathematics learners (see for example Boaler & Greeno, 2000). The origins of these beliefs may lie in the fact that gender, race and class exert an influence on how individuals variously experience the culture of the mathematics classroom, as evidenced in research by Black (2004 a,b), Boaler (1997), Cooper (2001), Dowling (2001), Gilborn & Mirza (2002), Kassem (2001) and Paechter (2001). That this process may begin very early in a learner's school career is evident from Black's work in a primary mathematics classroom which suggests that white middle class boys are more likely to receive invitations to engage in exploratory talk and extended discussion with the teacher as 'legitimate peripheral participants' than other groups. At secondary school levels, ability grouping becomes explicit and is characterized by particular pedagogic cultures. For example, Bartholomew's (1999) research suggests that there is a strong likelihood that teachers will have lower expectations of pupils in lower sets, and that these expectations correlate with different kinds of teacher-pupil interactions. Faced with higher ability sets, teachers are more likely to focus on pupil learning and involvement with the subject, and to engage in between-equals banter, particularly with the middle class male subset who 'belong there naturally' (Bartholomew, 1999:14).

We need to add to this mix the wider cultural discourses which are also part of individual self-positioning: gendered discourses of mathematics ability are lived out and gain major currency within the practice of ability grouping. As Bartholomew (2000:6) argues, 'the culture of top set maths groups, and of mathematics more generally, makes it very much easier for some students to believe themselves to be good at the subject than for others'. Top set boys are set apart from the other pupils by their confidence, speed and apparently effortless achievement of right answers – they are 'budding mathematicians', labelled as such by their behaviour and set membership rather than their actual performance in some cases. While other pupils work hard to 'earn a place' in top set, these 'high fliers' do not need to justify theirs. Significantly, it is girls in top sets who are likely to be positioned and position themselves as having 'less right' to be there and to experience a high level of anxiety (see also Boaler, 1997; Boaler et al., 2000). Mendick's research on post-compulsory (and therefore successful) mathematics students similarly shows that dominant discourses 'inscribe mathematics as masculine, and so it is more difficult for girls and women to feel talented at and comfortable with mathematics and so to choose it and to do well at it' (Mendick, 2005: 216-217). Similar effects are captured by Steele's (1997) notion of 'stereotype threat', which seeks to explain why women who identify as good at mathematics nevertheless remain uncomfortable with this aspect of their identity, running counter as it does to culturally-based assumptions. As Gee (2001) points out, some of the available discourses are more accessible and 'culturally appropriate' than others. I return to this anomaly in the identities of top set and successful students below.

Coupled with observations on group differences such as these, the theoretical approaches outlined above enable a more detailed understanding of how particular individual relationships with mathematics develop in terms of the dynamics of emerging pupil identities and their interaction with pedagogic practice. The reciprocal nature of the relationship between ability grouping, self-positioning and corresponding access to mathematical knowledge is demonstrated by Zevenbergen's (2005) research in particular; she argues that, while the lower ability group students in her sample were aware of the restrictions on them in terms of curriculum and pedagogy, they nevertheless developed a predisposition towards mathematics as negative and so behaved in ways which contributed further to their reduced participation. Thus, in lower sets, 'the students' reactions to what they see as inferior or poor experiences create a *habitus* whereby they behave in particular ways in their classrooms. They are creating a *mutual construction* of the classroom ethos: their behaviours can be seen as contributing towards a particular structuring practice—one which will contribute to their performance in mathematics' (p.616). In contrast, students in higher sets 'are more positive about mathematics, and have a greater sense of being able to achieve in the subject. …their experiences had enabled them to construct a mathematical *habitus* whereby they perceived themselves as well positioned in the study of mathematics….They have come to see themselves as clever and worthy of their positive experiences' (p.617).

The importance of identity is that it mediates the individual's relationship with the practice – in this case the practice of mathematics. Identities are constituted by, and constitute, classroom communities of practice which emerge as a product of short- and long-term processes and their interaction: deeply embedded pedagogic scripts, gender and ability discourses and discourses about mathematics, and the shorter-term incidents and events which are built on within the classroom through repetition and narrative combine to make up individual trajectories through mathematics. In this paper I re-ask Lemke's (2000:273) question: 'how do moments become lives?' by examining students' narratives of learning mathematics within different ability groups. Itself reminiscent of Leont'ev's (1978) idea of self 'as being a moment in the dynamic flow of activity that connects individuals to the world around them and to themselves' (Stetsenko & Arievitch, 2004, p. 488), this question helps us to maintain the emphasis on the interaction between 'individual mind and collective action' (Edwards, 2005b, p. 170) that lies at the heart of CHAT.

3. The study

The data for this paper are drawn from interviews with 18 girls and boys in years 9 and 10 (ages 13/14 and 14/15) attending a mixed 11-16 comprehensive in the north-west of England. The school sets pupils for mathematics from the beginning of Year 8, teaching in mixed ability classes in Year 7, their first year at the school. Participants were selected for interview by the head of the mathematics department, who was asked to pick pupils at random from the roll. Pupils were interviewed on a one-one basis for half an hour each. The format of the interview was open-ended, and covered the following topics: likes and dislikes in mathematics and other school subjects; the experience of SATs at KS2 (end of Year 6, before entry into their current school) and KS3 (end of year 9); ability grouping; effort and ability; creativity in mathematics; the experience of learning mathematics; working in groups; using mathematics in the real world; and differences between boys and girls in mathematics classrooms.

4. Analysis

The interviews were transcribed in full and analyzed thematically. This entailed assigning relevant pieces of text to categories initially generated from the basic interview questions. Further exploration of these categories was driven by the theoretical framework outlined above, and focussed on building a picture of students' relationships to mathematics in terms of levels of access to the construction of mathematical meaning and their related identities of participation and non-participation. This process generated the observations on trends in mathematics identities outlined below.

4.1 Top set identities: making meaning in mathematics

As many other studies have observed, one of the differentiating characteristics of top set life was its emphasis on speed, and Year 9 Michael presents a common link with innate ability when he says that 'some people can just like … see the answer in their head sort of thing so people like that, if they can just look at it and work it out it saves a lot of time so… because you've got to be born with like, some people are good at English, some people are good at maths'. However, top set identities are not necessarily dictated by the emphasis on speed, and Year 9 Luke positions himself as above this issue, because he has the more valuable capacity to see things in mathematical perspective:

> … I can understand how it works and I can see how it works and when I take time and think about it and look at it I can see it and I can do it right and correctly. …

Luke describes mathematics lessons as boring sometimes but he can see why this has to happen before it is possible to undertake more investigative mathematics projects. Indeed, he realises that there is a real distinction to be made between doing exercises to practice a set technique and applying a range of possible techniques to a problem:

> You have to be able to understand it so you can say "Oh look, this is whatever but I'm going to have to use this on it" and then you have to understand how to use it rather than just "This is all questions on whatever". Whereas in an investigation … you can say "Oh that must be Pythagoras and that bit must be whatever and that bit must need to use whatever".

He goes on to describe making connections and creativity in mathematics:

> It's good to be able to do that because, say, in between algebra and doing some normal maths or between algebra and say constructions and things like that, you can think "Oh yeah, I've done something a bit like this so I can use that knowledge to help me with this", and then maybe the two things actually combine together to make a different thing.

Luke argues that what distinguishes him from other pupils who are less able at mathematics is 'the difference between being able to do maths and being able to do the maths investigations', thus defining the parameters of a participative identity which is echoed by other pupils in the sample. Top set pupils generally reported a higher level of engagement in mathematics investigations – for example, Year 9 Georgia compared mathematics to art in terms of opportunities for creativity:

> Well sometimes when you're doing certain course work in maths you get to use your own sort of ideas as you do in art as well ….. Like if I just get the outline of the investigation then you just can put whatever to it yourself.

4.2 Teaching and learning: negotiated participation

These participative identities are explicitly linked to the kind of teaching that top set pupils experience in terms of content and also relationships with their teachers. Daniel, in Year 9, indicates the interplay between the ability to make connections and the opportunity to do so when he contrasts top and lower sets:

> .. we do more of, little bits of more things whereas the people who are lower down do more things with little bits so they don't see as much .. we sort of see it, we sort of see *all* the maths problems and how they connect to each other and we understand it more.

Top set pupils reported more intellectual challenge in their classrooms: a number of Year 9 pupils were working on an external competition which involved sustained investigation work in teams. They were enthusiastic about this activity, partly because it involved working with others, and partly because it entailed problem solving and taking a broader and creative view of mathematics. These pupils reported a change of relationship with the teacher in some cases towards acting as a resource, as Michael describes:

> [The teacher's role is] mainly just trying to explain things…. Once we get rolling we're usually quite independent and … we'll run it through her just to make sure she thinks we've gone about the right way of doing it. But that's about it really …. I only ask her as a last resort. I usually ask the people around me first.

Like Luke and Michael, Georgia sees the investigation activity as a creative learning opportunity, with the teacher as background support:

> It won't be the same as anybody else's idea. You get to add a part of you into the project ….you're using what you already know and then adding some bits that maybe you didn't know with the teacher's help or whatever. … If you don't understand something you can try and connect it to something else that you do understand which might make it easier for you to get better at it.

Georgia says that she sometimes tries to work out her own methods, and sometimes finds that these are easier than her teacher's suggestions. But she clearly sees the teacher-pupil relationship as one which works best with negotiation on both sides:

> I think you've got to get on with your teacher, try and see things from their point of view …. how they're trying to work it out and show you how to work it out. .. I think you probably have to do it more in maths….

Despite the pressure to perform and compete which comes with GCSEs, Year 10 top set pupils maintained an emphasis on working together to understand mathematics. Christopher described how his investigation experience working alongside Harry had been beneficial and creative:

> He did one bit, I did another bit, we kind of put our own ideas together …because sometimes you look at it one way and they look at it another way and then you can like work together with the different ideas you've got.

He has enjoyed being in the top set because he has had an opportunity to explore mathematics more, to understand a problem and its solution rather than following algorithms – 'it's using the stuff that we've been taught at school and applying it to the question'.

4.3 Lower set identities: facts, performance, and getting by

Lower set pupils presented an account of mathematics which suggested marginalised rather than participative identities, describing it much more as something 'done to them' (Schoenfeld, 1992). In fact, Year 9 Trevor does not appear to know what I mean when I ask him about whether he likes doing investigations. He describes mathematics in terms of performance and memory, and he has an instrumental view of its use: he wants to be a truck driver and is focussed on learning the school mathematics necessary for that job and life in general:

> I want to be a truck driver so I've got to like see how many hours I've done … work out the exact mileage and everything. …When I go with my dad and my mum shopping, like buying stuff and it's seventeen point five per cent, they might need to work it out before they go up and buy it…

Commensurate with his emphasis on memory is Trevor's basic concern with his marks – he talks about his performance often, in sharp contrast to Luke, for instance, who never mentions performance directly. When I ask him about how he did in the recent SATs, he gives me a lot of figures:

> I'd say I'd got about … over fifty per cent, like the average, around fifty-eightish, something like that. Because the last one I got overall I think was seventy-eight per cent, something sixtyish … so I was pleased with that because my mum said she was happy. At least I got over fifty per cent.

Lizzie is in the same set as Trevor but is somewhat more reflective about what is involved in mathematics. However, she too has a perception of the main aim of mathematics as a question of finding whichever is the easiest way of doing a calculation as opposed to anything more creative. What is interesting about Lizzie, however, is her obvious liking for investigations. She contrasts the drill of set exercises and the creativity of investigations in a way which is similar to Luke's:

> It's not like [you] have a sum set for you. You can start working it out and then you'll get different leads and you'll go off in a different direction and everyone at the end of it will come out with something different. … With a set sum you just have to get the answer but with an investigation you can answer loads of questions and you can try it with different things.

Lizzie's particular mathematics history is that she used to be in the top set, but has been moved down. Despite her obvious liking for the challenge of investigations - which she had undertaken in the top set in Year 8 but not in her year 9 set - she lacks Luke's confidence and self-positioning as a legitimate peripheral participant, falling back on an understanding of mathematics learning as based on fixed ability and a picture of mathematics itself as largely pointless. Like many other pupils, she believes that 'some people have just got it and other people just find it harder', and she has a cynicism about mathematics - like Trevor, she's not really sure of the point:

> The teachers say you'll need maths when you're older. But you're not going to need simultaneous equations or graphs when you're older unless like you're an accountant or something. ... You're not going to need to know all this. But I think it's just to prove how clever you are sort of thing.

Year 10 Paul also says that he enjoys investigations because they allow him to work at his own speed and to evolve his own, more memorable, methods, but he is emphatic about not working with others because this puts him off. This emphasis on working alone appeared to be a direct result of the stress on performance generated by GCSEs. Ben, also in Year 10, was highly competitive about his GCSE practice investigation, with limited benefits for his mathematics understanding, it seems, in that ‘You want to get to the lesson and just get into it … and you’re wanting to find more than other people’. His reply when asked what he had learned from the investigation is simply ‘how to get on’ in terms of sticking at a task. What he might have gained in more mathematical terms is unclear, despite much prompting:

> I didn’t hardly speak at all, I did a lot of work in that [*And what was the end point?*] There were lots of different ways [pause] can’t quite remember [*What was your target?*] As many as possible and trying different grids and how many different, enlarging the grids [*Did you actually generate any kind of formula for how things related to each other?*] No I don’t think so. [*So what did you learn maths-wise?]* Puzzles sort of thing [pause] [*Is there anything you’ve learnt from it that you’d be able to apply next time?*] [pause] I don’t think so, no.

4.4 Lower set learning: ritual and marginalisation

Lower set experiences of doing mathematics at school seem to be largely coloured by a perception of the teacher-pupil relationship as one based on a positional teacher authority, an outlook which fits with an emphasis on performance. Trevor appears to lack the experience that many top set pupils have of learning as a process of negotiation between teacher and learner: asked if he ever shares his own ways of solving problems with his teacher, he responds in terms which suggest that the main aim is not to get told off:

> If we’ve got the right idea but don’t get the right answer, they don’t tell us off, still like, at least we’ve tried.

Lizzie’s ideal mathematics lesson suggests that lower set teaching provides few opportunities for engagement:

> I’d make it more interesting. ... Because we get exercises and it does help you to understand what you don’t know and what you do and get to work on it but I wish they could think of new ways to teach it … more investigations so you could sit there and do it for yourself … and make you think properly

Year 10 Anna also described how she likes to be active in the lesson, to think for herself and to work in groups. Her experience of mathematics lessons, however, is that they are a matter of endurance, boring, pointless and lacking in activity and fun. Enjoyment is a central theme in Anna’s interview; she sees enjoying mathematics as the main difference between pupils in the top set and herself, and she is emphatic that she can never be good at mathematics because she does not enjoy it, although she concedes that she might begin to if she could do more active investigations ‘because we’re actually doing it ourselves and not having to listen to someone explain it’. Her lack of control over what she does in mathematics is crucial:

> It depends if you want to do it or not … if you choose to do it you enjoy it more because it’s what you want to do. But if you don’t chose it and you get forced to do it then it’s different … we do pointless things all the time.

5. Theorising developing identities: interactions between pedagogy and discourse

These accounts suggest contrasting understandings of mathematics and experiences of teaching and learning between the top and lower sets which are associated with corresponding identities of participation and marginalisation. Top set learning appears to be characterised by Wenger's prescribed mix of opportunities for engagement, imagination and alignment as pupils not only learn the basics but how to manipulate these in a negotiated and reflective mathematics. Lower set learning on the other hand appears to be a simple question of blind alignment. Thus Georgia, Luke, Michael, Daniel, Christopher and Harry recount teaching and learning relationships in their top sets which appear to foster, or stem from, participative identities, while lower set pupils Anna, Lizzie, Ben, Paul and Trevor describe lessons which are dominated by memorising facts and algorithms, and an accompanying identity of marginalisation.

The data do not fall uniformly into such neat categories, however. Among the top set pupils, Georgia seems to be the only girl to express a truly participative identity. For example, Jenny, one of the Year 9 top set girls, describes her experience of mathematics in ways which match more closely to lower set marginalised identities:

> The teachers tend to show the hard way .. a lot of the time. They do show you an easier way but only briefly because they just want you to do the complicated way so you probably can pick up more marks or something.

Despite her advocacy of the challenge of top set work, Year 9 Rosie also expresses strong likes and dislikes for particular areas of mathematics, avoiding those which she finds difficult, while Lizzie says that she is glad not to be in top set any more as she was unable to work at the required speed, an aspect of the top set which both she and Jenny particularly identify with the boys' behaviour. Year 10 Rachel had been promoted to the top set at the end of Year 9 on the basis of her SATs performance, but maintained nevertheless that she was no good at mathematics, despite her insightful treatment of the noughts and crosses investigation which meant so little to Ben. This gender difference is most sharply drawn in the cases of Harry and Sue, the only pupils in the whole year group to be taking GCSE mathematics in Year 10, a year earlier than the vast majority of pupils in the UK. While Harry describes himself as 'above average', and talks enthusiastically about real world applications of mathematics and his ambitious approach to the coursework noughts and crosses investigation, Sue describes herself modestly as 'quite good' at mathematics, and Harry as much more advanced:

> You know, Harry's a very good mathematician so his [coursework] is really good. … he is more advanced, he knows more things that we have to do … in tests he can take the formulas out of the front of the paper and put them to the questions and some of them I don't know what to do with them.

When pressed on why this might be, Sue conceded that some of these questions covered issues that they had not yet been taught and that Harry 'must do things at home'. She agreed – but very reluctantly – that in the right circumstances she could be as good as Harry. It was not clear, however, if Sue really believed this; asked directly about effort and ability, she maintained that effort was important, but then, as many other pupils did, went on to say that 'Some people really aren't … as good. Some people can't learn as much'.

It appears, then, that gender is crucial in the development of participative identities. While girls such as Sue, Lizzie, Rosie, Jenny and Rachel show clear indications of making important connections in mathematics and a taste for investigative mathematics, they lack identities of participation such as those which are particularly evident in the accounts of the top set boys. A neo-Vygotskian perspective such as Edwards and Mercer's (1989) or Mercer's (1995) analyses of exploratory talk and the engendering of ritual versus principled knowledge suggests that the kind of classroom interactions which characterise top set mathematics should be of benefit to all pupils. This is indeed the case: the top set pupils, including the girls, expressed understandings of mathematics which involved making connections and creativity – they display in this sense modes of belonging which map onto engagement and imagination. Yet the girls' marginalised identities present an anomaly which is also recorded in earlier research showing top set girls' anxiety as I have noted above. As Stetsenko & Arievitch (2004, pp. 478-479) suggest, the equation of subjectivity with participation in a community of practice means that such transactional approaches 'do not focus either on how particular selves are produced, or on the active role that the self might play in the production of discourse, community and society itself'. All this raises the question, reminiscent of Lemke's observation on the uniqueness and typicality of classrooms, identified by Sfard & Prusak (2005:14) as central to an investigation of learning: 'Why do different individuals act differently in the same situations? And why, differences notwithstanding, do different individuals' actions often reveal a distinct family resemblance?'

Sfard & Prusak's answer to this question is 'to equate identity-building with story-telling' (p.21). Taking issue with Wenger's claim (p.151) that identities are more than words, they argue that 'it is our *vision* of our own or other people's experiences, and not the experiences as such, that constitutes identities. Rather than viewing identities as entities residing in the world itself, our narrative definition presents them as *discursive counterparts* of one's lived experiences' (p. 17). If we consider Gee's notion of unique trajectories through "Discourse space" we can understand how these pupils might position themselves and be positioned within the mathematics classroom, and the different ways of being that it affords, so that identities are formed over time and have their roots in repeated positionings and repeated stories. Their individual Discourses frequently appeal to a Nature-identity (if we include the idea of natural ability in this), but also incorporate Discourse-identities which draw on discourses about mathematics and of gender differentiation. Institution-identity is clearly ascribed in terms of ability group membership, while Affinity-identity appears in the students' accounts of their within-class groups, such as the gender groupings which girls rather than boys allude to frequently.

Ability grouping thus has a complex role in pupil identities. To return finally to the research reported by William and Bartholomew: they report that differences in GCSE outcomes between higher and lower sets are most marked in schools which used formal whole class teaching (p.279). The data reported here suggest that one reason why this might be is that classroom practices which foster identities of participation and hence higher attainment are not only less likely to happen in lower sets but they are also less likely to happen in any situation where pupils lack the opportunity to work in small groups or to establish relationships of negotiation with their teachers. Over and above this, however, we need to see that the selective development of participative identities is a product of both pedagogy *and* discourse: what pupils experience in mathematics classrooms will always be coloured by the stories they tell.

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