

Povey, Hilary and Burton, Leone with Angier, Corinne and Boylan, Mark (1999) Learners as authors in the mathematics classroom. In L. Burton (ed) *Learning Mathematics, from Hierarchies to Networks*. London, Falmer.

Introduction

In this chapter we explore authoring as the means through which a learner acquires facility in using community-validated mathematical knowledge and skills. As an author, the learner uses their mathematical voice to enquire, interrogate and reflect upon what is being learned and how. What does it mean to say that a learner of mathematics is an author? For the majority of classrooms, authorship appears to be vested in the mathematicians who derived what is to be learned, and the texts through which that mathematics is conveyed. We believe that such a view ignores what is known about the process of coming to know which, far from being one of cultural transmission, is necessarily one of interpretation and meaning negotiation in the context of connectivity to current personal 'knowing' as well as to knowledge situated in the community. This we believe to be a lifelong struggle to accord meanings to the narratives which describe the personal, the socio-cultural and, inevitably, the political. Without such meanings, it is difficult to make sense of why so many people fail in, or discard, their attempts to learn mathematics and, in particular, why so many of these unsuccessful learners are predominantly found in particular communities.

This leads us to ask three questions which will guide the development of this chapter.

- How does characterising mathematics learners as authors help us to uncover what might be liberatory discursive practices in the classroom?

To answer this question, we invoke models of different ways of coming to know in order to allow us better to theorise the learning of mathematics as located within pedagogical practices which support critical mathematics education.

- In what ways does understanding mathematics as narrative help to change the classroom experiences of learners?

We explain our understanding of mathematics as a socio-cultural artefact similar to language. Any particular 'piece' of mathematics can then be located, spatially and in time, and be 'understood' within its cultural context. One outcome of this approach is to take away some of the mysticism and power of mathematics and to re-locate respect to the learners, as well as those who have discovered or invented the culturally powerful tools and knowledge.

- What are the classroom discourses and practices which foster or deny the authorship of learners of mathematics?

We use empirical data to explore this question in order to embed our theorising into the practices in classrooms.

Coming to Know Mathematics

Three contrasting epistemological perspectives, three different 'ways of knowing' (see Belenky et al., 1986) are found in the mathematics classroom (as elsewhere): *silence*, *external authority* and *author/ity*. We are not claiming that these perspectives cover every epistemological stance nor that a learner will, inevitably and irretrievably, be located in just one of them. But, viewing classroom experiences through this lens, helps us to understand how different pedagogical practices are experienced by learners.

The first perspective, that of *silence*, is where learners experience themselves as "mindless and voiceless and subject to the whims of external authority" (Ibid: 15). It cuts off the knower from all internal and external sources of intelligence. Such learners do not see themselves as developing, acting, learning, planning or choosing. They may have no vantage point from outside the self from which to view their situation or may see themselves only as the object of such a gaze. They feel 'deaf' because they cannot learn the words of others and 'dumb' because they have no voice. The perspective is immobilising making the mind blank so that the sense of knowing is lost. It is accompanied by fear, loss of a sense of agency and feelings of powerlessness (see Buerk, 1985, Buxton, 1981, Isaacson, 1990). By its nature, although apparently so widespread, it is unlikely that, as teachers, we 'hear' this way of knowing in our classrooms. It is illustrated when learners find their voice again and can look back on the experience of silence: "it is like a stainless steel wall-hard, cold, smooth, offering no handhold" (Buerk, 1985:) ... "the wall comes up" ... "down comes the blanket like a green baize cover over a parrot's cage" (Buxton, 1981:4) ... "if unable to answer some fate worse than death would be waiting" (Isaacson, 1990: 23). Laurie Buxton pointed to a key link between the generation of this state of silence and the presence of authority external to the learner. It is a way of knowing likely to be experienced in a classroom which is predicated on an epistemology of *external authority* to a description of which we now turn.

The second epistemological perspective, possibly more commonly experienced than any other in mathematics classrooms, is that of *external authority*. Authority is experienced as external to the self and belonging to the 'experts'. Meaning is taken as given and knowledge is assumed to be fixed and absolute rather than contextual and changeable. The knower is deeply dependent on others, especially authoritative others. This is the voice which asks "Is it an add, miss?" (Brown and Kuchemann, 1976) and it is the one to which many mathematicians from the hegemonic group would have us listen:

A common cause for concern is that there is far too much emphasis on self-discovery rather than the presentation of material as a body of knowledge (Professor Crighton, THES, February 24, 1995: 6)

Much, even, of those practices advocated as 'discovery' is also predicated upon external authority as the appropriate way of knowing; indeed the learner is understood to be discovering the already known mathematics just as the mathematician is deemed to discover mathematics which is implicit to the system: "Nearly all research mathematicians believe that mathematics is discovered. This is subjectively how it feels when one is working" (Epstein, 1994, private communication) The authority for the learner rests in the content. The authority for the mathematician rests in the subject. In both cases, the authority is external. Paul Cobb, Terry Wood, Erna Yackel and Betsy McNeal gave an account of a teacher striving to work with her students in a 'discovery' mode, offering practical activities intended to evoke for the learners the mathematics to be learnt. However, a fundamental assumption behind the pedagogy was that the children's purpose when they engaged in mathematical activity was to match the teacher's intellectual expectations, in a sense to re-tell the teacher's story. In particular, "[e]very challenge identified was made by the teacher, and, in this sense, she acted as the sole validator of what could count as legitimate mathematical activity" (Cobb et al., 1992: 587). (See Edwards and Mercer 1987, especially chapter 7, for a sensitive account of similar practices within the science classroom and Barbara Jaworski, this volume, for a sympathetic discussion of this difficulty for teachers.) More commonly, of course, 'delivery' of the teacher's knowledge is not simply implied by the pedagogy: it is explicitly given as the goal.

The third epistemological perspective is that of *author/ity* (Povey, 1995). Teachers and learners sharing this way of knowing work implicitly (and, perhaps, explicitly) with an understanding that they are members of a knowledge-making community. (The authors of each of the other chapters in this section have useful things to say about how such community meaning making might be conceptualised and/or practised.) As such, meaning is understood as negotiated. External sources are consulted and respected but they are also evaluated critically by the knowledge makers, those making meaning of mathematics in the classroom, with whom *author/ity* rests. Such a way of knowing opens up the possibility of understanding knowledge as constructed and meaning as contingent and contextual and personal in the sense that it reflects the positionings of the knower. The teacher and the learner meet as epistemological equals. They work together to comprehend the world and to forge more adequate representations of it, which may include de-naturing the present and re-visioning and re-envisaging the future (Kenway et al., 1994: 202). It is therefore potentially emancipatory.

Within *author/ity*, we want to use the epistemological perspective suggested by Patricia Hill Collins (1991). She offers four dimensions that help to assess knowledge claims. These are: *concrete experience as a criterion of meaning*, *the use of dialogue*, *the ethic of caring* and *the ethic of personal accountability*. We believe that these four dimensions comfortably describe *author/ity*, as we

understand it, as well as giving us a useful tool to use in making judgments about the efficacy of the mathematics classroom.

Concrete experience as a criterion of meaning allows for “subjectivity between the knower and the known” (Ibid: 211), relying upon her direct experience as a valid form of creating, testing and affirming meaning. Affirming the links between the concrete and the mathematical abstractions that are drawn from that concrete seems a necessary part, to us, of building mathematical competence and confidence.

The use of dialogue in assessing knowledge claims demands that such claims are subject to both connectedness and critique within a community of knowers. We understand the process of making meaning, with Deborah Hicks, as that:

of the child as actor within emergent and non-deterministic discourse contexts. As the child moves within the social world of the classroom, she appropriates (internalizes) but also reconstructs the discourses that constitute the social world of her classroom. This creative process is what I would term learning. (Hicks, 1996: 108/9)

The ethic of caring suggests, to Patricia Hill Collins “that personal expressiveness, emotions, and empathy are central to the knowledge validation process” (op. cit.: 215). In the context of the mathematics classroom, this re-locates author/ity within the learner(s), respecting them for what they bring to the struggle for meaning, rather than reserving respect for the authorities who validate the communal knowledge. Between the personal expressions and the empathy of other learners lies the space for establishing similarity and difference, for drawing out analogy or establishing the boundaries within which a statement is valid. The ethic of caring requires that critique within the classroom is both a requirement *and* a responsibility which students and teachers accept in offering positive intellectual and emotional support while, at the same time, pointing out discrepancies and/or difficulties in argumentation.

The ethic of personal accountability calls upon learners to justify, to engage in debate, to provide an evidential basis for their knowledge claims and to be willing to participate in such activities as fully responsible members of the community of learners. (There are resonances here with Terry Wood and Tammy Turner-Vorbeck, this volume.) Ways can then be found for mathematical knowledge claims in classrooms to “stand the test of alternative ways of validating truth” (Ibid: 219).

Author/ity and Critical Mathematics Education

Author/ity as a way of knowing can be further explored through a concept of narrative. We all use narrative “to make sense of our life experiences ... to give meaning and some semblance of coherence to our lives” (Clark, 1993: 32). Mathematics can be appropriately construed as narrative because it is “an essentially interpretive activity” (Brown, 1994:141), mathematical expressions being thus understood not as objects with internal inherent meaning but as hermeneutic

acts uttered within a social space that is contingent upon context, culture and coherence. If mathematics is understood as the 'telling of a story', then each of us gains greater autonomy as an author of that mathematics, but not at the expense of a deep commitment to the social context of life and meaning making. The very notion of telling a story presupposes at least an audience and at best an active community of meaning makers.

[N]arrative always communicates within a community involving story teller(s), sometimes listeners, or readers, and sometimes participants. It engages others in the attempt not only to tell but also to explain and, ultimately, to understand the experience which has provoked it. (Burton, 1996: 30).

The notion of mathematics as narrative helps us to 'see' the authors of mathematics within a community. This human meaning making has been expunged from the accounts of mathematics that appear in standard texts; the contents are then portrayed in classrooms as authorless, as independent of time and place and as that which learners can only come to know by reference to external authority. The teacher becomes

a Pythagorean educator wishing to reveal to children the eternal Divine Forms of which children's experience must inevitably be but a confused anticipation or a pale reflection. (Winter, 1992: 91)

Because the author(s) of the narrative remain hidden, mathematics becomes a cultural form suffused with mystery and power, a discourse which mystifies the basis for cultural domination. (See Winter, 1992, Skovsmose, 1994 and Burton, 1996 for a discussion.)

Understanding mathematics as narrative opens up the possibility of a more equal relationship between the teacher and the taught in mathematics classrooms. Nicholas Burbules and Suzanne Rice have noted that "teacher authority, even if it is adopted with beneficial intent, takes significance against a pervasive background of relations of domination" (1991: 396) and therefore needs constantly to be re-examined and called into question in an emancipatory classroom. If the task of learners in the mathematics classroom is to be, jointly or severally, the authors of their own mathematics, the culture of the classroom must be one in which an epistemology of *author/ity* is fostered. Constructing a narrative, acquiring authorship, cannot be done on the basis of the external authority of others but needs the participant(s) to understand themselves as the makers of knowledge, tested out within their community of validators (Cobb et al., 1992: 594). It also, of course, requires that such participants are not silenced in the sense outlined above but have a personal voice.

Such a classroom is one in which teachers and learners strive to approximate to the ideal speech situation posited by Jurgen Habermas and summarised by his translator.

[T]he structure (of communication) is free from constraint only when for all participants there is a symmetrical distribution of chances to select and employ speech acts, when there is an effective equality of chances to assume dialogue roles. In particular, all participants must have the same

chance to initiate and perpetuate discourse, to put forward, call into question, and give reasons for and against statements, explanations, interpretations, and justifications. Further more, they must have the same chance to express attitudes, feelings, intentions and the like, and to command, to oppose, to permit and to forbid etc. (McCarthy, 1975 quoted in Carr & Kemmis, 1986: 143)

In such a space, learners can tell their own stories about mathematics, the differing accounts and interpretations being subjected to productive dialogue in the search for more adequate descriptions of reality. The classroom changes. It is no longer a drill ground “reflecting the commands put forward in the curriculum and made audible by the teacher” (Skovsmose, 1994: 185), which practises “a system of oppression [which] draws much of its strength from the acquiescence of its victims who have accepted the dominant image of themselves and are paralyzed by a sense of helplessness” (Murray, 1987: 106, quoted in Collins, 1991: 93). It becomes a space for the inculcation and acquisition of the communicative virtues (Burbles & Rice, 1991: 411) which, in turn, are predicated on relationships of equality and respect for each of us as authors.

In mathematics classrooms in which the learner is the author/ity of knowledge, they have the opportunity to use their personal authority both to produce and to critique meanings, to practise caring in a dialogic setting where the effectiveness of their own narrative(s) and also those of others is refined. The teacher and the learners will (implicitly) understand that they have “constituted mathematical truths in the course of their social interactions and that acts of explaining and justifying were central to this process” (Cobb et al., 1992: 592). When the learner’s understandings do not fit with those of others, they are encouraged to engage in “talk, discussion, suggestions and conjectures and refutations, or shifts of thought through resonance” (Lerman, 1994: 196), that is, to engage in the practice of critique, a practice fundamental to creating potentially emancipatory discourse.

Author/ity in Practice

We wish to embed this theorising into the practices of the classroom, to try to make it 'fact-laden' (John Mason, this volume). But, as will be obvious, exemplifying the classroom discourses which foster the authorship of learners of mathematics is unlikely to be successfully done by presenting 'authorless' snippets of teachers and learners at work. *The meanings for the teachers* of their actions in the classroom are going to be central to understanding, in practice, how they foster author/ity: how they nurture respect for concrete experience as a criterion of meaning, how they promote dialogue, how they help to generate an ethic of caring and of personal accountability. We offer here extracts from the reflective writing of two secondary teachers who are committed to such a perspective. We invited them to read the chapter thus far and to use the ideas as a stimulus for thinking about their own classroom practices. We then wove their writing and ours together to construct the rest of this section.

Striving for clarity about what one wants to achieve is a starting point. Corinne is concerned to move her students from fearful mathematical silence to an

epistemological location where they have the opportunity to express their author/ity. She writes:

As a teacher I find that the children in my classroom are desperate for dialogue on all sorts of levels. The challenge for me is to provide them with the space in which to develop their mathematical voices and not to drown out their efforts in a cacophony of discordant demands. As a friend, a parent, a sibling, I find it much easier to allow dialogue on somebody else's terms. I happily participate in hundreds of conversations with my own children that lead into blind ends; a luxury I rarely afford the children I teach. In the classroom there is always the curriculum, the lesson plan, the implications for classroom management, most of all there is the fear of anarchy ...

This starting point allows her to focus on the narrative usually constructed in mathematics classrooms and to critique her own actions as they reflect current practice.

I remember a mixed ability lesson on percentages with my class of eleven year olds.

Me: What does per cent mean?

Five hands shoot up. (I seem to have forgotten the strategy of tell the person next to you, now tell your table and so on.) Twenty five people are already feeling voiceless. I select one hand.

Child A: It means in the shops you get 50% off.

How can, how should, I reply to this. The child has stated what percentage means to him at the moment. He is therefore right but on the other hand the lesson exists to move his understanding on and so he is not right enough! What might have happened if I had responded as a person not a teacher?

Me: Yes that's right. I expect everybody has seen those kinds of signs up in the shops. What were you going to say?

Child B: It means if its 10% off then that's 10p in every £1.

Me: Very good, it does. That's something to do with how many pence there are in a pound. Does anybody know what cent means in French? (I write cent on the board.)

Anonymous voice: One hundred.

Me: That's right ... what were you going to say?

Child C: Does it mean out of 100?

Child C clearly felt that the initial question had not been answered, that the class had not yet produced the desired result. I greeted her answer with enthusiasm which the class picked up on as meaning that's it, we've cracked it. All of us then breathed a collective sigh of relief. Had any of us really achieved anything at all?

This incident draws attention to a very real difficulty with teacher questioning: teacher questions seem to imply answers and those then seem both predetermined and already known.

As well as enabling her to see differently some practices currently accepted, Corinne's starting point also allows the possibility of understanding 'deviant' practice

differently and of recognising the need to renegotiate the complex space within which students can pursue meaning making.

Later in the lesson, after a number of activities, child C shouted out, "10% is not really very much, is it?" Child B joined in. "No they just do that to make you think you are getting a bargain." I joined in with their cross class chat by suggesting that 10% of a large lottery win might be quite a lot of money. More people joined in and a far more meaningful discussion took place - or perhaps a disruptive girl pulled half the class off task? It was, of course bad classroom practice; children should not shout out, they should not have conversations across the room and certainly the teacher should not join in and hence condone such behaviour. How can teachers provide space for children to express the things they've just thought of?

Taking seriously the notion of children as authors of mathematics involves a more fluid and responsive structure to mathematics lessons. Building such a classroom culture takes a considerable amount of time.

Mark had been working with the same class for more than a year and had a number of experiences which were telling in moving himself and the class forward. In these reflections on a particular lesson with them, we see glimpses of what it can mean for students to be the authors of mathematics and the significance of this for them as learners.

I have come to identify with a radical tradition in education that seeks to develop educational practice in such a way that it can help to nourish personal development and social change ... A significant concern is how can I create the conditions whereby my students think more critically about mathematics, themselves as learners, the learning process, schooling and society ... One incident that helped me think about how the gap between my theory and practice might be closed arose out of a lesson on infinity and the students response to it ... I was stuck for a lesson for the last lesson with my class of fifteen year olds on the last Friday of a long half term. The tradition was to play some sort of mathematical game. (It is an indictment of our National Curriculum [in the UK] that its effect is so unexciting that a game is seen by teachers and students as a relaxing release from its pressure and, by implication, that maths lessons being enjoyable is a rarity.) However I had the idea that I wanted to do something different and decided that a lesson on infinity was a much better idea. The students took some convincing that 'going lobster fishing' wasn't a better choice.

The lesson was investigative and largely orally based. It was clear during the lesson that many students had thought deeply about the concept, even if it was on the part of some students to deny its reality. This was a 'good' lesson in the sense that our current regime of inspectors teaches us how to think about lessons in that nearly all students remained on task throughout the lesson, they used and learned mathematics at the higher levels of the National Curriculum (calculating with fractions, deriving sequences by iteration, summing to a limit). This was important to me because in the short-term it feels necessary to show that teaching in a different way ought to be successful in those terms as well as giving more besides. Feeling a little carried away by its success, I set them a homework to do over half-term (much moaned about at the time) on the lesson. I asked them to do two sides of A4 on infinity. The choice of the content was up to them, they might choose to investigate some infinite series of their own, to write about the history of the idea, their own ideas about infinity or to write a poem (no takers for this one but that's hardly surprising as the number of poems by 'proper poets' on the subject is not very large).

The students' response was qualitatively different from previous pieces of work ... I was teaching in a working-class school set in a large council estate with high levels of poverty and unemployment. The students' image of themselves as learners is generally low ... In addition there exists a counter culture

in the school which derides achievement and interest in learning; this is particularly prevalent amongst boys in the school. The students' responses were the most individual pieces of work I had received. I felt that I had set them a difficult task and they had responded very well. I felt pleased with what had happened but did not spend too long thinking about it.

Later in the year students had to write formative records of achievement and select one piece of work that they felt most proud of. To my surprise the majority of students chose the work they had done on infinity ... When I discussed their choices of work with them I realised that for a number of them their view of learning and themselves as learners had changed in a small but important way.

Mark also offers an account of a more 'commonplace' lesson, a surface description of which might have much in common with classrooms predicated on a very different epistemology. We have to read through the lines in order to hear the validation of specific experience, the centrality of dialogue for building shared meaning, the respect for what the learners bring and the call to justify their knowledge claims within a community of learners.

I think my students get a lot from the collective strength of tackling a problem together ... One lesson I wanted my fourteen year old students to get practice in using Pythagoras' theorem, a new topic for them. I saw an opportunity to explore trial and improvement methods at the same time. I didn't have a clear idea of exactly where the lesson was going to go, preferring to let the students' response guide me.

I started by setting out a problem from recreational maths. Sue, a forest ranger, is 300m east from a river when she sees smoke from a fire 1000m north and 400m east from her. She has to run to river, collect a bucket of water and then run to the fire to put it out. Obviously she needs to do this in the shortest time possible and so must run the shortest distance from her position to the river and then to the fire.

The students' first task was to agree in pairs on a diagram that would model the problem. We then shared these on the board. A class discussion then followed on what might be the best solution, some students asserting that she should run directly east and then diagonally to the fire, others stating that she run diagonally to the river and then go east, whilst the rest argued for two diagonal runs. The students came and drew diagrams on the board of their proposed solutions, identified right angle triangles and quickly realised that all of their proposals would need to be tested by using Pythagoras. We worked through one triangle together to make sure everyone was happy about applying the rule in this context.

They set to work in pairs to calculate distances for their preferred solutions ... Comparing answers we agreed that we couldn't be certain that any of the solutions was the shortest distance. A little nudging led to the idea of searching for a solution and we agreed on steps of 50m. The work was divided up and more distances calculated.

We collected the solutions in a table. The design of the table provoked some controversy but the majority wanted as much information as possible in it. All possibilities were attempted by at least two pairs and this meant that the class checked each other's results. When differences of opinion occurred we all worked through the triangles and had the chance to discuss some common errors. In the situation of a shared goal the error makers didn't seem particularly embarrassed but rather valued for adding a useful contribution to the experience. Examining the table led to the decisions to narrow the range of the search and we tackled the problem again at 5m intervals and then finally we narrowed the solution down to the nearest metre.

We discussed some extensions and most students worked through the problem again setting their own initial distances at home. One pair tried to see if they could find the point Sue would get to the river given the total distance and another decided that Sue wouldn't be able to run as fast once she was carrying a bucket full of water and with some guidance found a new solution to the original problem taking this into account - although their assumed running speeds would have made Sue a world record middle distance runner by a long way! All homeworks were completed on time - a very unusual occurrence with this class.

Tasks which can be approached in a variety of ways and which depend upon a range of different responses can provide a particular opportunity for nurturing an alternative epistemology. Mark and Hilary were together involved in two lessons when a class of fifteen year old students, during a visit to the university, worked on the idea of geometric construction. In groups, the students spent part of the time using a variety of material - geostrips, tissue paper circles, pairs of compasses - to construct a square in as many different ways as they could, sharing their results later with one another and explaining what they had produced. They were also asked to re-construct a particular figure (of an equilateral triangle produced by two circles) using dynamic geometry software, to set themselves the task of constructing some other constrained triangle (for example, isosceles or right angled) and finally some polygon(s) of their choice. Groups compared and contrasted their approaches and only needed a little encouragement to believe that alternative paths might lead equally to success. The fact that all the pairs set themselves to work with a will and had no difficulty in setting themselves a task and tackling it is a result of patterns of working which Mark had established over time. Nevertheless, the students noted and valued particular features of these sessions. Lucy said:

I liked doing them circles best, the ones with the triangle, we thought about trying to do a scalene triangle but we didn't have time. We thought that were good when we were trying to work out about why [the equilateral triangle] did that ... it took us more than once to try and work out the first time and then once we'd got that we could like go on to other things ... I liked it because we had to experiment.

The students were asked to write up their reflections on the experience.

The work we did was quite challenging and I enjoyed it a lot. I enjoyed puzzling things out and trying my ideas. I also enjoyed being part of the 'group' and knowing that I was there to not just work on my own but to work with someone I could talk to, work with and relate to. It also felt good to be able to talk to other people about my work ... (Joanne)

I also learnt that maths isn't just writing, there are lots of practical things you can do ... (Patrick)

I also learnt a lot about myself. I learnt that I can work with a partner and in groups to solve problems, and I can work on a puzzle until it is solved, correcting mistakes I make and learning from them. (Matthew)

... the work we did involved more thinking and remembering what we had done, at school we usually write everything that we learn or have learnt in the past. (Zoe)

Mark, in turn, reflected on the students' response.

Studies have shown that students from working class schools spend a significantly greater amount of time than other students writing. The approaches to learning that the students described and valued

have been an important part of the way I have tried to work. Nevertheless the unspoken realities and culture of school life have nudged me in the direction of 'write it down'. There is a strong fear that if there is not a written record of work done then the work will be less valid. I recognise how this displays a lack of confidence that students really will learn more through discussion: they had better have a written record to help them 'revise' in case the content is not learnt ... Is the current emphasis in the [UK] National Curriculum on record keeping, evidence, inspection and testing a pressure away from the oral and group work these students so enjoyed? ... It is ironic that the students who were critical of their usual diet of 'writing things down' were much more enthusiastic when writing their own record of the visits: here the process of writing was a creative individual act.

These visits helped Mark in his attempts to look behind the taken-for-granted practices of schooling and the epistemology on which they are based which restricts the use of a caring and accountable dialogue in the construction of mathematical meaning. Corinne describes how a pupil shadowing exercise illuminated for her how those practices inhibit the voice of the student and neglect the potential of the knowledge making community which is the class.

I was involved recently in a shadowing exercise, following a fourteen year old pupil, which amongst other issues brought home to me just how 'silencing' the classroom environment is. In an art lesson I watched as a teacher tried to interest her students in a display of lettering whilst they were otherwise occupied. Eventually one of the girls listened and started to 'argue/discuss' but she was reprimanded for talking out of turn even though she was the only person willing to engage. The message goes out that sitting and silently ignoring a teacher is more commendable than taking issue. This observation was repeated in technology where again a girl made a pertinent observation and started asking insightful questions but was ignored then fobbed off. Later in science it was the same story when a boy started to question the structure of the atom. Just the same thing happens in maths lessons. We appear to be determined to make our classes walk along predetermined paths that are called lesson plans, schemes of work and so on.

During my pupil shadowing day I talked to three fourteen year old students for an hour. I asked them to tell me about any experience in school where they felt they had really learned something. One of the boys described a lesson the previous week when a supply teacher had taken them for science and he had answered all of the boy's questions, engaging in conversation and discussion for nearly an hour. I asked one of the other students whether this hadn't been a bit boring for the rest of the group. 'Oh no,' he replied, 'it was great. We were all listening and joining in a bit, it's just that Tim asked most of the questions.' It is a classical way of learning. It is how most pre-school learning takes place and fortunate children have a parent or friend who is willing to go on engaging in discussion on the child's terms. It seems to be a rarity in school. We are so locked into an ideology of performance and testing that we dare not depart into the realms of true enquiry. We do not allow ourselves the time to meander in directions chosen by our pupils.

Skovsmose notes that 'when the orientation is decided by the child, an epistemic 'energy' is released' (Skovsmose, 1994, p. 69). It is this epistemic energy which can be seen 'as something people possess which must be annexed in order for larger systems of oppression to function' (Collins, 1990, p. 166, drawing on the work of Audre Lorde). It is this epistemic energy that needs to be released if mathematics classrooms are to be the site of critical education.

Conclusion

In this chapter we have explored how the characterisation of mathematics learners as authors can help us uncover aspects of liberatory classroom practice. We have argued that fostering an epistemological perspective of *author/ity* amongst teachers and learners will support a renegotiation of the relations of dominance embedded within current conceptions of the nature of mathematical knowledge. Such an epistemological perspective takes the concrete and the personal as the starting point for meaning making; it recognises the vitality and significance of dialogue in the process of knowledge construction within a community; it relocates the privileging of the read *and* written in the mathematics classroom into a more coherent approach drawing upon speaking, listening, reading and writing and emphasising meaning construction and negotiation; and it nurtures within that community an ethic of care and of personal accountability. Sal Restivo (1992) has written,

Some of the representations of dominant groups are likely to be labeled as self-evident, and put to use to enforce conformity, put a subject beyond dispute, and deal with ambiguities and anomalous events. (Ibid: 125)

Much mathematics has functioned as such a representation. It is our hope that the ideas in this chapter will support a challenge to mathematics thus viewed and will help open up the power of the subject to learners within communities to whom it has so far largely been denied.

References

- Belenky, M.F., Clinchy, B.M., Goldberger, N.R. & Tarule, J.M. (1986) *Women's Ways of Knowing: the Development of Self, Voice and Mind*, New York: Basic Books.
- Brown, M. & Kuchemann, D. (1976) Is it an add, miss? *Mathematics in Schools*, 5(5) 15-17.
- Brown, T. (1994) Towards a hermeneutical understanding of mathematics and mathematical learning in Ernest, P. (Ed) *Constructing Mathematical Knowledge: Epistemology and Mathematics Education* London: Falmer Press.
- Buerk, D. (1985) The voices of women making meaning in mathematics *Journal of Education* 167(3) 59-70.
- Burbles, N. & Rice, S. (1991) Dialogue across differences: continuing the conversation *Harvard Educational Review*, 61(4).
- Burton, L. (1996) Mathematics, and its Learning, as Narrative - a Literacy for the Twenty-first Century in Baker, D., Clay, J. & Fox, C. (Eds.) *Challenging Ways of Knowing: In English, Mathematics and Science* London: Falmer Press.
- Buxton, L. (1981) *Do You Panic about Maths?* London: Heinemann.

Carr, W. & Kemmis, S. (1986) *Becoming Critical: Education, Knowledge and Action Research* Lewes: Falmer Press.

Clark, C. (1993) Changing teachers through telling stories *Support for Learning* 8 (1).

Cobb, P., Wood, T., Yackel, E. & McNeal, B. (1992) Characteristics of classroom mathematics traditions: an interactional analysis *American Educational Research Journal* 29(3) 573-604.

Collins, P. Hill (1991) *Black Feminist Thought: Knowledge, Consciousness, and the Politics of Empowerment*, London: Routledge.

Edwards, D. & Mercer, N. (1987) *Common Knowledge: The Development of Understanding in the Classroom*, London: Routledge.

Isaacson, Z. (1990) "They look at you in absolute horror": women writing and talking about mathematics in Burton, L. (Ed.) *Gender and Mathematics: An International Perspective* London: Cassell.

Kenway, J., Willis, S., Blackmore, J. & Rennie, L. (1994) Making "hope practical" rather than "despair convincing": feminist post-structuralism, gender reform and educational change *British Journal of Sociology of Education*, 15(2) 187-210.

McCarthy, T. (1975) *Legitimation Crisis* Boston: Beacon Books.

Murray, P. (1970) The liberation of black women in Thompson, M.L. (Ed.) *Voices of the New Feminism*, Boston: Beacon.

Povey, H. (1995) *Ways of knowing of student and beginning mathematics teachers and their relevance to becoming a teacher working for change* PhD thesis, University of Birmingham, School of Education.

Restivo, S. (1992) *Mathematics in Society and History*, Episteme 20, Dordrecht: Kluwer.

Skovsmose, O. (1994) *Towards a Philosophy of Critical Mathematics Education*, Dordrecht: Kluwer.

Winter, R. (1992) "Mathophobia", Pythagoras and roller-skating in Nickson, M. & Lerman, S. (Eds.) *The Social Context of Mathematics Education: Theory and Practice* London: South Bank Press.