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## Mathematics and Comprehensive Ideals

ANNE WATSON

**ABSTRACT** This article revisits methods and debates about teaching mathematics that were common in the 1980s and early 1990s, and then moves up to date with the findings from three mathematics departments that set out to make a difference for their lowest attaining students. The methods they used were distinctly focused on core mathematical ideas, and how all students could work with these. This Vygotskian approach supports students' development towards thinking in new-to-them mathematical ways, rather than accessing mathematical enquiry through particular social structures or non-mathematical modes of engagement. The author claims that any school which does not take seriously the mathematical understanding of the lowest achieving students is not truly comprehensive.

When I was head of mathematics at Peers School, Oxford (now an academy), I wrote in *Forum* about how we tried to provide equal opportunity in our mathematics teaching (Watson 1993). We taught mathematics to whole tutor groups, and split them into tiered GCSE entry groups during spring term of year 11, having first engaged them individually in choices about entry tier. We focused on developing mathematical modes of enquiry and mathematical ways of thinking rather than on covering particular topics and learning a set of skills. Mathematics was explored through projects, extended tasks, applications, puzzles and the occasional practice of necessary routines. I wrote at the time: 'We are fortunate in having a National Curriculum which is just a list of the content which goes to make up our subject. We are also fortunate in our Attainment Target 1 which encourages us to be aware of the processes of mathematics ... we enjoy the challenge of putting these together but as a framework, not a straitjacket. We do not feel that the craft of teaching has been taken away from us, nor that we have had styles dictated to us.'

I left the following year to pursue an academic pathway. A year or so later, GCSE assessment was restructured, with more focus on final examinations and less on coursework. Mathematics GCSE results fell from around 33% of the cohort to 17% at C and above. Although our students still significantly

outperformed comparable students in schools which taught setted classes in traditional ways, pressure was put on the newish head of mathematics to alter the methods – they were deemed no longer fit for the purpose of achieving good GCSE grades in a target-driven market place. The school returned to teaching methods which had been shown in comparative research to be generally less effective but this focus on traditional teaching for traditional testing led to short term gains. Two new, young, energetic, knowledgeable and highly-skilled teachers made sure of that. The school was closed a few years ago so you can tell that this effect did not last.

I had argued that setting for mathematics is a direct contradiction to comprehensive ideals, and that schools in which this happens – nearly all of them – are not true comprehensives. The power of the mathematics grade to define the future of a student is overwhelming, and yet for most students the grade is defined by the group in which they learn mathematics in year 7. This has been defined by their KS2 level, the outcome of which may be due to setting from as young as year 3. The school buildings might indeed provide a roof for all students, and teachers may do wonderful pastoral work, but the educational pathways under the roof are restricted. Was I really being too idealistic in believing that all students could have access to tasks and teaching that made all grades possible? In addition, what was it about those methods that led to the fall in achievement when the method of assessment changed?

Since then I have worked to understand more about the key aspects of good mathematics teaching that might have helped our students not only to be better at mathematics than comparable students elsewhere, but also to be as good as the middle class students up the road. My focus has shifted away from groupings. I pragmatically accept the status quo of setting in most schools and have decided that the key issue is not the groupings, but the expectations and how those can be exceeded. The job of the person teaching the ‘bottom set’ is to make it no longer the ‘bottom set’. How can this be done (Watson 2006)?

To my delight a few years ago three schools separately contacted me to tell me they were going to alter the ways they taught mathematics in order to raise achievement for all students. They all believed they could rescue the mathematical learning of students who entered secondary school having failed to achieve level 4 at KS2. I asked if as researchers we could watch what they did, and they agreed.[1]

In terms of school measures there is little to be gained by trying to do better for the very weakest performing students, so we should not underestimate the courage they had to take this stance rather than the more usual strategy of focusing the best teachers and extra resources on borderline achievement. To focus on the weakest requires a moral stance about the nature of community, as well as confidence about a relationship between students’ minds and the nature of mathematics – a confidence without which little is possible. It requires resistance to performance culture, resistance to models of teaching based on mechanistic target setting, resistance to models of learning that imply simple concept acquisition, confident articulation of beliefs, and the power to persuade

colleagues and managers. In addition, all three schools decided for various reasons to teach year 7 in pastoral groupings, so persuasion of parents would also be required since for all the schools this was a change of practice. Two of the schools, which we called Lawrence Sterne and Spenser, served inner-city areas of social deprivation, one of them highly multicultural, the other predominantly white working class with about 40% SEN, 40% FSM and only one EAL student. The third school, called Field Harrow, served a diverse rural area. Each school had an entry cohort of around 180+ students, organised into seven teaching groups.

To support other heads of department who wish to make similar changes, we created a website to disseminate the details of their practice ([www.cmtip.co.uk](http://www.cmtip.co.uk)) but before you decide whether to look at the contents of this it is worth reporting their results. We watched them for three years until KS3 SATs, so used comparison between the SATs results of the focus cohort and the previous year as one ‘measure’ of success. For contextual purposes we have included other core subjects in the results in Table I.

‘Passes’ in year 9 national tests as %	Spenser School		Field Harrow		Lawrence Sterne	
	2007	2008	2007	2008	2007	2008
Year	2007	2008	2007	2008	2007	2008
<b>Maths</b>	47	61	79	80	53	62
<b>English</b>	59	56	76	69	48	43
<b>Science</b>	46	45	77	69	53	54

Table I. National test results in core subjects for our cohort 2008 and 2007.

So presumably the headteachers were delighted with the mathematics departments, and the changes they had made to their practice were recognised and praised! In the first school the job description of the head of mathematics was changed so that he was expected to become a generic manager of learning. Responsibility for mathematics was devolved to someone who tried to re-establish traditional methods and the ex-head of mathematics left to focus on mathematics teaching elsewhere. In the second school the mathematics department was deemed not to have made progress, although a glance at the results for other core subjects suggests a different story. In the third case the mathematics department did not achieve high enough levels at GCSE, thus being blamed for plunging the school into a survival crisis and a change of leadership.

These stories of lack of appreciation from management remind me of the mathematics teacher in Boaler’s book (2002) whose students did exceptionally well in GCSE, better than any other group in the school and much better than the comparative school. He would not change his methods and practices to conform to the headteacher’s idea of acceptable teaching and took long term

sick leave, never returning to teaching. In Boaler's more recent work (2008) she reports how his students, then several years on, recalled the teaching methods with appreciation of their beneficial effects.

In all of these stories you will recognise the pressures on headteachers, so what about the lowest achieving students who are usually beyond the performativity measures anyway? In two of the schools the results of such students were significantly better than similar students the previous year, but in Field Harrow they had dropped – so maybe they really had failed to 'reclaim the secret garden'. In Spenser School, such students were in the majority, so were critical in changing the school's overall fortunes. That was the school which had the greatest rise in results.

In addition to all this measuring, we talked with a focal group of such students from each class of each school, and found that, contrary to the more usual growing disaffection with the subject, students in these schools maintained a positive view of the subject during KS3 and a more or less positive view of their own progress in it. The only group for whom this underwent a bit of a wobble in year 8 was a group in Field Harrow.

Although all schools started out by teaching year 7 in pastoral groupings two of the schools returned to setting for year 8. Spenser, the school that made most difference, did not. Reasons for such a return were threefold: beliefs that some students were being held back and others not getting good support with basic numeracy; a perceived need for more of a focus on content knowledge and less on the development of ways of working; staffing constraints leading to the use of non-specialist staff. In Field Harrow there was a change of department leadership with the new HoD wanting to rethink and focus on the following cohort, albeit with similar aims, so 'our' research cohort reverted to previous practice or to versions of what they had done for year 7 without collegial support for teachers. In Lawrence Sterne the change to setted groups was accompanied by maintaining new ways of working that had characterised their year 7 work, and therefore, taking these results together with those of Spenser School, I believe it was these ways of working, rather than the groupings, that made the difference. In Field Harrow a significant number of the lowest achieving students were taught by a non-specialist who gave them low level arithmetic tasks, persuaded parents to purchase a particular textbook that he preferred, and openly disagreed with department policy on many matters. I do not wish to overgeneralise from so few cases, but it is worth asking about the common features of those schools and teachers that made a positive difference. What were these, and how do they relate to comprehensive ideals?

Teachers' expressions of what they want to do, and why, and how, were so similar to what we had developed at Peers, and what was going on in many other schools, in the 80s and early 90s, that I have to keep reminding myself that this was not an intervention project in which I was promulgating out-of-date views of equality. This was new thinking, within a very different context, by mainly young teachers who had no direct experience of earlier times but accepted the challenge of equal opportunity and, perhaps more strongly, a

notion of educational redemption. There was a strong feeling that a key role of mathematics specialist teachers in secondary school is to redeem the latent mathematical capabilities of students who, until then, may never have been taught by someone who understands the subject well. Leadership was crucial, and in all schools there was one senior teacher who did have past experience of 'mixed ability' teaching, and teaching that focused on the development of ways of thinking and working rather than content and performance. But digging out old banks of resources from the Association of Teachers of Mathematics, or the ILEA Smile programme, was only part of the story. The younger teachers had been 'trained' and established some personal identity in leading the collective thinking of a class through discussion and orchestration of ideas, rather than supporting individual and group open-ended exploration as had been the norm in earlier times. The younger teachers' sense of zeal was for their students to understand key mathematical ideas, rather than to display valued methods of enquiry which focused on modes of working rather than what was learnt.

This was also the critical difference I had been working on since leaving Peers. At Peers we had veered slightly towards a weak interpretation of Piagetian teaching: put the students in a potentially mathematically rich environment, support the thinking, and learning will follow. In the three schools, in year 7, I was seeing something more powerful: a Vygotskian understanding of the teacher as mediator of scientific ideas, and a Gramscian drive that all should have access to what the 'elite' know. Without strong intellectual guidance from knowledgeable teachers, those with the weakest social skills, and the flimsiest take on classroom cultures, would do little more than apply everyday thinking to mathematical situations. At Peers that had been good enough to do well at GCSE at a time when problem-solving, adaptability, and application were more highly valued. In current times, when displays of knowledge and skill have been more valued, different teaching was required and these teachers had worked out how to do it. In the process they could show me the elements that had been missing at Peers, how teacher intervention at the whole class level can make a difference to the conceptual understanding of individuals by engaging them in the dynamic processes of constructing meaning. In the 40 videos of lessons I have watched from the three schools, I am convinced that many students learnt mathematics during those whole class episodes because of the methods of knowledgeable mediation used. Interactions between teachers and individuals or small groups were *additional* to the central, shared, working, whereas at Peers this had been the main method of teacher knowledge input. I noticed, for example, the following difference: a teacher can use a whole class mode to work on motivation, context, and task transitions, and an individual mode to work on mathematical ideas; or can use a whole class mode to work on mathematical ideas and an individual mode to work on motivation and transition. This difference was especially striking when I watched an experienced teacher who had been overseas for a few years and came back to apply the first of these methods. It was common in the 80s that the mathematics was individual whereas for the younger teachers in the three

schools the mathematics was public. The first method enables teachers to differentiate by input, task, and hence reify their preconceptions about students' capabilities. The second method enables teachers to differentiate based on students' dispositions towards work, but not according to the core subject knowledge being work upon. This is equal opportunity in the sense of access to core cultural knowledge; the first is equal opportunity in the sense of social modes of participation.

As I write, the purpose of education is again in flux and I am wondering what can be learnt from the experiences of these three schools and my reflections on them. Universities and employers are again complaining, as they did before the Cockcroft report (1982), that as a result of narrow testing and a prescriptive curriculum entrants are inflexible and incapable of creative application of mathematical knowledge. At the same time the new government has shown its preference for lists of content rather than the complex generic descriptions of the educative process and context that have recently been developed by QCDA. It has also stated its commitment to continuing KS2 'rigorous' assessment. But it is now more widely understood by policy makers that the mathematical learning of *all* students is important, not merely the highest achievers or borderline cases.

To provide a comprehensive education for all must, therefore, include access to the core ideas of mathematics and not merely to using everyday reasoning within numerical and spatial contexts. All students need to be able to do mathematical reasoning and thinking, using precise comparisons; exclusive classifications; deductive arguments; and understanding the effects of relational variations. To learn to do this requires teachers who understand these themselves and who can ratchet students' thinking towards mathematical standards. It is possible, therefore, that if a teaching team do not feel they can do this in all-attainment groups, because to reason mathematically requires a knowledge and skills base which not all students have, then teachers with most understanding need to teach those with least, so that they become more able to learn mathematics. My friend, the late mathematician Christine Shiu, taught 'bottom sets' when she was head of mathematics at Countesthorpe in its early days for precisely this reason. Field Harrow also recognised this and made sure that the students who had the unhelpful teaching in year 8 were provided with a rescue team of two very experienced, highly qualified, teachers in year 9, but it seems that this may have been too late for rescue by KS3. The focal group of students cheered up in year 9 and began to feel more positive again.

#### *Note*

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**ANNE WATSON** taught mathematics in challenging schools for thirteen years before becoming a teacher educator. She has published numerous books and articles for teachers as well as pursuing research into improving mathematics teaching and learning. She focuses particularly on those students who do not normally achieve well in school mathematics, believing that underachievement is a social justice issue. She is currently Professor of Mathematics Education at the University of Oxford. *Correspondence:* Professor Anne Watson, Department of Education, University of Oxford, 15 Norham Gardens, Oxford OX2 6PY, United Kingdom ([anne.watson@education.ox.ac.uk](mailto:anne.watson@education.ox.ac.uk))

