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The Possibilities and Difficulties of Teaching Secondary Mathematics in All-attainment Groups

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ABSTRACT It is a well-established norm in England that secondary school mathematics is taught in groups categorised by prior attainment. It is therefore worthwhile to report alternative practices of all-attainment teaching – but these are rare. In this article, we report aspects of all-attainment mathematics teaching in a secondary school that has maintained this practice as its norm over a considerable time, including in recent years, when a hierarchical approach to measuring mathematics learning has become the norm for accountability purposes. The teaching described here takes account of the needs and progress of different students within a common curriculum focus, and we identify key principles behind it. The article is intended to contribute to a record of all-attainment grouping practices in mathematics in England, so that these practices are not lost.

In a recent issue of *FORUM* (2011) Anne wrote that the aims of all-attainment grouping in the teaching of secondary mathematics were not always clear, and, where they were clear, were not easy to pursue in the current climate of accountability. Methods of teaching mathematics in all-attainment groups in England range from using resource banks to guide individual pathways to using group work to solve problems and conduct investigations. Anne wrote that, for her, the key task was to enable all students to develop the forms of reasoning and fundamental knowledge that would enable them to progress in mathematical study and that this task, rather than the structure of the groups, should be the starting point for deciding how to teach. Since mathematics is a gatekeeper for so many routes to advancement, the attainment of all students is an issue that has social justice implications. Layered onto this is the national traditional expectation that certain students should make exceptionally fast progress, while others will not make much measurable progress at all. In contrast, therefore, to countries where similar progress for all is the aim and

expectation, teaching at secondary level in England tends to separate students according to past attainment.

Some schools have recently introduced all-attainment grouping in Key Stage (KS) 3 in order to lay equitable foundations for secondary mathematics, but those with whom Anne worked in the Changes in Mathematics Teaching Project (CMTP) returned to setting before KS3 assessment because of institutionalised expectations of widely differentiated levels of achievement (Watson & De Geest, 2011). By contrast, for this issue of *FORUM*, we look at some teaching of all-attainment groups in a school where this is a well-established norm for mathematics. We present Gwen's own insider knowledge and practice and examine what is possible. We discuss her practice in the light of two common criticisms: firstly, that 'mixed-ability teaching' does not necessarily provide for extension of the strongest mathematicians and secondly, that it does not necessarily transform the abilities of the least successful learners.

The Belper Setting

Belper School was founded in 1973 as a co-educational comprehensive school in Derbyshire, originally with visionary open-plan buildings. It is now an 11-18 school with about 1500 students on roll. Since it started, as an amalgamation of grammar and secondary modern schools, it has had a reputation within the education community, among local teachers, and among primary school parents, of being 'a bit right-on'. There is no uniform and teachers are called by their first names. These features, as anyone who has worked in such a context can testify, need not result in a lack of discipline, but they have some significance as the outward face of a school in which the relationships between staff and students are less formal than in many other schools. They also represent the remains of Belper School's history of being once at the progressive edge of advances in education. More significantly, but less visible to the public, Belper mathematics faculty has managed to hold on to its original commitment to teaching mathematics in all-attainment groups throughout KS3. Moreover the reintroduction of linear GCSE courses this year has led to all-attainment grouping being extended into Year 10, since the linear structure permits late decisions about tiers of examination entry. Teachers at Belper have been teaching this way for so long that, when Anne was teaching at Stantonbury [1] in 1984, Belper's mathematics faculty was already becoming a legend.

Gwen taught at Belper for ten years. She says that the mathematics faculty at Belper is not populated by ideologues who spend lunchtimes discussing the latest educational research. Rather they are a dozen ordinary teachers 'who happen to teach at Belper', few, if any, having come because of its all-attainment commitment. Since this is the norm at the school, people are committed to this way of organising things – and because it seems to work. Indeed, two of the staff were students at the school themselves so knew what they were coming to. The school's senior management take a hands-off approach to ideology, allowing heads of faculty the freedom to develop their own ethos within their

spheres of influence, rather than imposing uniform practices across the curriculum. Indeed, the modern language faculty teach in attainment sets, and students somehow manage the seemingly disjointed experience of moving between these different forms of teaching.

It is not easy to operate an all attainment curriculum in the current climate, although the original aim of the National Curriculum (NC) was to provide access to the same entitlement for all. However, the NC models mathematical knowledge as discrete chunks with a linear progression through a hierarchy, rather than as a synoptic subject. The National Strategy, a centrally-provided set of non-statutory guidance documents, goes further in trying to tie these chunks to a student's age. The advisory medium term planning frameworks provided by this strategy break this down further by suggesting the pace and timing within which groups of learners should assimilate this knowledge. All the official guidance documents mitigate against a holistic view of learning and assume homogeneous, linear, fragmented learning in terms of knowledge and rate of progress. When schools are inspected it is assumed that they will follow the Strategy guidelines unless they can provide a substantial argument and evidence for alternatives.

To move away from the curriculum structures suggested in these documents, endorsed by many inspectors and school improvement agents, and to deal with the pressure to produce exam results for accountability purposes, both require confidence and even belligerence when the prevailing assumptions are that setting and curriculum fragmentation are the only way to achieve good results (Venkatakrishnan, 2004; Beswick et al, 2010). It would require even more confidence, commitment and knowledge to *change* to all-attainment groups without having had time to engage with research and academic support. However, at Belper such grouping is well-established rather than innovative; we now examine how it works in practice.

How Does It Operate?

KS3 schemes of work are built around the medium term plans provided by the National Strategy, but these are used for guidance and not as straitjackets.[2] In practice, at Belper teachers decide individually what content they can afford not to cover, thus freeing time to spend on essential concepts in depth. With an eye on the scheme of work, most lesson planning starts with some learning objectives. The objectives that best fit the guidance documents for the age group may not be appropriate for the whole class, meaning that other objectives must be created for those who may struggle to access the concepts and also for those who may already have a good understanding. In this respect, planning is similar to how many teachers differentiate their teaching by having core, extension and support goals. This process in most schools has the potential for three times as many learning levels to be expected as there are sets, but at Belper most variation is in the content rather than in expected 'levels' of learning. At some point in planning, it becomes necessary to find suitable tasks and activities

that will provide opportunities for learners to meet the intended learning objectives. Belper has an extensive resource bank of worksheets of varying quality built up over nearly 30 years. It takes some hunting and trialling to locate relevant tasks, particularly as few commercial resources fit closely with Belper's ethos. After a time teachers develop their own preferred resource banks but there are no shortcuts for teachers new to this way of teaching. Textbooks can also be helpful in thinking through the components of a conceptual area. However, to use textbooks as a resource in this way requires them to be conceptually-focused, with contents pages and indices, and without the assumption that students would be using them in a linear fashion. This kind of textbook has long gone in the drive for measurable micro-steps of learning.

Resourcing the all-attainment curriculum was a central issue for the CMTP schools who changed to this grouping in Year 7, and in those schools the researchers saw that there were no shortcuts to teachers feeling ownership of the resources. It took time and deliberate shared planning for all teachers to feel involved (Beswick et al, 2010).

How Did Gwen Teach ... ?

We now move to Gwen's report of her teaching, written in the first person.

> My best lessons with all-attainment classes use open-ended tasks (and in this respect, the current fashion for 'rich tasks' suits Belper's style of working). If I have written the tasks myself they are often more appropriate, because they have been written specifically for a particular situation, and sometimes a particular class of children. There is a satisfying simplicity in everyone starting with the same problem, and such a situation can accelerate those that are accustomed to low attainment; even if they are not accessing the extension work directly they are observing the direction it is taking, often at a desk next to someone who is using more sophisticated methods. For example, one task is to build a tower from a cuboid, a triangular prism and a tetrahedron. For some students, designing and creating just one of these solids from card would be challenging. But I also added that each solid must use not more than one sheet of A4 card, that the tower should be as tall as possible, but still self-supporting. These extra constraints, with which students can engage or not as they feel able, means that the task can be accessible and challenging to a wide range of abilities. When students peer-assess the towers at the end of the session, they can learn from each other's approaches.
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> This sort of differentiation by outcome can be used for more structured tasks as well. When investigating to find a rule for the co-ordinates of the midpoint of a line, the initial task involves just finding the midpoint of two numbers. Students then move onto finding the midpoint of two co-ordinates on a horizontal or vertical

line, and finally look for a rule to find the midpoint on a diagonal line, with students choosing to move on when they feel they have completed each task. Whilst not all students will get as far as the final task, a finishing whole class discussion will expose the formulae which give a different kind of access to all – formulae as tools whose purpose is obvious to those who have worked on the simpler tasks.

Open ended tasks are not always possible, or desirable. When teaching equations, for example, I enjoy asking students to write their own equations, then put them on the board for one another to solve. A very varied set of equations then appears on the board and students choose which ones they want to solve.

Even if the task itself is quite limited, students' learning can be extended by the addition of some probing questions to think about. For example, students might be engaged in investigating which kind of triangles will tessellate. By suggesting that students might like to think about why and how their triangles tessellate and encouraging them to write down or explain their thinking, the task is extended enormously. When they have engaged with looking at angles at a vertex, students might then like to think about how this extends to the use of triangles in creating solids where the properties of angles meeting at a vertex are no longer so clear.

I find group work invaluable when working with all-attainment classes. When investigating the angles in a polygon, a group can be given all polygons up to 10-sided to draw and find the sum of the interior angles. This is a daunting task for one student but for a group of four or five it is manageable; the work can be shared out so that the more confident tackle the harder shapes. They can check each other's work, compare results, and those who finish first can pick up the remaining work. By having a shared results table, patterns can be sought and all students can be confident that their work is a valued part of the whole, whilst some can have more insight into the results than they might by working alone. Groups can also be organised to look at one another's work in different ways so that they can learn from the approach of other groups as well.

When, through lack of imagination, time or energy, or a perceived need for routine practice, I feel the need to use textbooks, I take three piles of books and ask students to choose which to work from. I provide a quick self-assessment starter on the board on the particular topic, and this allows me to signpost students to the appropriate book. For example, 'If you can already do ones like this, you should have a go at book A but leave out the first 10 questions ... If you want more practice on these, try book B'. Students are always free to move between books if they have made the wrong choice, or feel ready to move on, and my responsibility is to

> understand what learning might take place from the different sets of questions. In my classroom, students expect to help one another and work together even when working in their individual exercise books.
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> I use a regular change of seating plan as this can also expose capabilities that would not otherwise be recognised, simply because of the working dynamics of the particular grouping of students.
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> Once students are engaged in the task, I will often suggest certain directions for particular students to explore.
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> All students are therefore immersed in the same spectrum of activity, exposed to other ways of working than their own. Gwen's account amply demonstrates how extension and enrichment of the work being done by everyone provides opportunities for the development of high-achieving students. However, we need to address the possible Vygotskian criticism that being present in an environment that provides the possibility for new ways of thinking is not enough on its own to transform capabilities – there needs to be interaction with the teacher. Gwen poses the question: Is it possible that, as a teacher, I engage in fixed ability thinking, judging what a child is capable of in advance of their work?
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> Undoubtedly this happens at times, but a critical aspect of my all-attainment teaching is to give most of the responsibility to the students in deciding what level they should be working at. Often I will make the extension work available to all, publically signposting it on the board or on written materials. Learners can choose whether they feel ready to tackle it in this particular topic, on this particular day, with this particular partner.

In this respect, her teaching of secondary mathematics is similar to some of the practices reported throughout Wroxham School (Swann et al, 2012), namely giving students *choice* while informing them about *challenge*.

Whilst a teacher might be making judgements about challenge as well as other interventions, there is also space for a student to achieve highly on one area of mathematics while needing to do more basic work on another. Two of Gwen's students Ron and Joe in Year 7, for example, really excelled at algebra.[3] Whenever they tackled algebraic work they confidently manipulated level 6 material. However, later in the year they were set the challenge, mentioned previously, of building a tower from three solid shapes. Ron and Joe found this task immensely difficult and did not have the strategies to manipulate their 3D visualisation onto the 2D piece of card. Their final work would have been assessed as level 4. This sort of variation in attainment within individual students' work across mathematics is not unusual and is easily manageable in a mixed-attainment setting. Students whose pace of attainment varies dramatically over time can also easily be accommodated. For example, Jill was assessed at level 2 in maths at KS2 and then went on to achieve at level 6 at KS3, gaining a

C at GCSE. If Jill had been put in a bottom set at the beginning of Year 7, as she would have been at some schools, the outcome would probably have been very different. These stories highlight the need for *openness about expectations* both across mathematics and also across time. In other words, these all-attainment groups provide the raw material and the time and space for transformation.

It is possible, using methods like Gwen's, to provide meaningful mathematics lessons that are cognitively challenging for a broad spectrum of students. This is a desirable aim if the purpose of teaching mathematics is that the majority of students should engage in authentic mathematical ways of thinking and make progress in solving problems using mathematics. However, it is much more difficult to cover the broad spectrum of declarative and procedural knowledge prescribed for various attainment levels to be reached in national tests. Some students may need to spend time revisiting earlier topics to consolidate their understanding while others may need to learn brand new ideas in order to achieve the highest possible levels.

Before the abolition of KS3 SATs, which were a measure of attainment levels used to compare schools, there was usually a handful of students in Gwen's Year 9 classes who would be capable of learning ideas such as standard form or trigonometry; this would be required in order to show the school in its best light, as well as being an entitlement for those students. But the class could become fragmented with these students studying from textbooks, with occasional episodes of help. Some teachers would arrange after-school classes to cover such topics. Another element of fragmentation could be that students who had not yet mastered basic mathematical techniques would be unable to fully consolidate these before being offered higher level opportunities. However, when such students were encouraged to engage with more complex mathematical reasoning, they often stayed interested in mathematics for longer than if they had faced several repetitions of basic techniques – an approach to learning that becomes associated with feelings of failure. In studies of teachers working holistically with previously low attaining students, there is evidence of increased engagement and effort (Watson et al, 2003) in contrast to the usual loss of enjoyment experienced at KS3 (Sturman et al, 2008).

It is this difficulty in addressing the topics associated with different levels that has led to the widespread rejection of all-attainment groups in the face of a national curriculum with a hierarchical structure. High-attaining students have been expected to study higher level topics, rather than being encouraged to work with more depth on the same content as everyone else.

Students' Expectations

This brings us to an important reflection on the culture of mathematics lessons at Belper School.

> I give students a large degree of responsibility for making sure that they are working at a level where they feel sufficiently stretched and

> supported. With a new class (particularly in Y7), this is a new learning culture, so it takes some time for students to get used to; when offered tasks of differing difficulty, many start by opting for the easiest. Most students quickly recognise that this results in boredom and soon begin to want to show what they are fully capable of achieving.
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> I have observed that some students will extend work themselves by looking more deeply into the structure of a problem they are working on. Students like this make the teacher's job much easier, so as a teacher I was interested in how to get more students to be able to think like this. It was often the focus of a conversation I would have with students at parents' evening if it was suggested they were not being 'stretched'. A skilful teacher will also be able to capitalise on the expertise of students who can work like this by making their probing questions public so that others can consider them. They can also be asked to explain their understanding. This sort of exposure can model to other students how they might be able to extend their own thinking and ask their own questions. Similarly, as the expert in the classroom, I model probing questions myself so that students have an accessible repertoire.
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> Copying work from someone else without understanding rarely happens at Belper – students can see that there is little point when their focus is on learning.

Again, these comments are similar to those made about The Wroxham School, by both staff and pupils.

The lack of copying was something Anne found both at Stantonbury and at Peers School. If there are regular conversations between teacher and students about their work and their understanding, and if the work being handed in to be marked has been created during lessons with teacher interaction, there is no reason to copy, but also no way to hide any copying. Anne reports being mystified when coursework at GCSE was criticised as giving too much opportunity for copying, because if mathematical work is ongoing continuously in class and home, and students have to explain it, inauthentic work is immediately exposed. On the other hand, when coursework deteriorated into a formulaic requirement so that there was no room for originality, this advantage was lost and copying became more frequent.

We could explain students' choices in terms of theories which connect engagement with self-efficacy, self-concept, views of intelligence and attribution, but in practice teachers do not need to theorise, beyond recognising the need to work continuously on developing students' choice of challenge. The concepts about self that are relevant when expecting autonomous engagement in traditional tasks are less relevant when inducting students into a culture of choice, because:

> as the teacher I can work continuously on helping students learn to choose. I would at times suggest that a student might want to try something more difficult (or easier).

Another aspect of Gwen's teaching and other similar mathematics teaching is that there is no final answer that signals the desirable end point. If the classroom has a *coherent, sustained, learning culture* rather than an answer culture, students will soon adopt it. The culture of doing mathematics towards a unique answer is, however, ubiquitous. It is recognised by textbook publishers who omit answers from the student books, and reified by assessment methods that focus on short answers to routine questions. In our teaching, we prefer answers to be given so that students can diagnose their own errors and put them right, and maybe use answers as a starting point for new questions. Fortunately, mathematics always contains its own authority so there are usually ways for autonomous students to check answers themselves when answers are required.

Developing a *collaborative culture* is critical to allowing all-attainment groups to work with only one teacher in the classroom. One teacher we know expects students first to use their brains, then look in a book, and finally ask their friends, before they ask the teacher for help. As Anne said in her previous article (Watson, 2011) transforming how students think is ultimately the teacher's responsibility, but so is the development of *autonomy and independence*, which includes knowing when, why and how to practice procedures. Continuing choice into the need to practice procedures, both of us used textbooks sometimes to provide such practice, but current textbook authors do not seem to understand how to structure sets of questions in order to generate either fluent procedural knowledge and/or conceptual enquiry.

All-attainment Teaching and Institutional Support

The complicated balancing act required to plan lessons makes teaching in an all-attainment setting difficult and challenging, especially for new teachers who have not yet built up a bank of resources or confidence in their own ability to orchestrate and juggle multiple pathways of learning. Added to this is the extra insecurity of not 'fitting in' with the accepted prevailing culture of emphasising exam results in a particularly prescriptive and formulaic way. Anne comments that some new teachers who want to teach like Gwen, even in classes grouped by prior attainment, have problems finding schools that will support their efforts to do this. There has to be support from above and below and both sides to make it work, and at Belper it works because 'this is the way we do things'. Support and sharing of resources and ideas between colleagues are essential and this is always the first agenda item at Belper department meetings, as well as taking place informally. This pattern of deliberate discussion of tasks emerged in the three schools Anne researched; in particular, there was a shift from assuming a task could be expected somehow to ensure a particular learning outcome, to thinking instead about how students would learn while doing it

and hence about the associated pedagogy (Watson & De Geest, **forthcoming UPDATE?**).

At Belper there is support within the department, but beyond that there are no local non-setted schools for collegial support, and no formal links with those in the academic world who advocate the approach. Within the school, the department is expected to conform to the belief that 'every child should know what level they are working at and how to get to the next level'. Indeed teachers are required to assign a sub-level to students three or more times per year. Belper's maths teachers are caught between trying to develop a structure of mathematical learning that can allow every child to develop at their own pace in different spheres of the maths curriculum, whilst simultaneously having to measure and assign numerical levels to those same children.

When KS3 SATs were abolished, Belper abandoned all formal testing in KS3 but simultaneously the demands from outside to assign levels were increased. The school developed a time-consuming system of Assessing Pupil Progress (APP) [4] that has all the right intentions of enabling teachers to adapt their work continually to students' understanding. Essentially however, any such system that micro-records every step of learning for individuals is liable to embody teacher judgements much of the time, because of the pressures under which it is constructed, and because of the difficulty of making judgements about a subject that is synoptic rather than hierarchical. Even when – and if – the discourse of 'levels of attainment' is removed in the current reform of the NC, the power of the accountability discourse in education is unlikely to lessen; teachers will continue to need to find a way to operate between this dominant official discourse and their personal *discourse of inclusivity*. The negative effects of the grip of the 'assessment for learning' discourse may be hard to escape, associated as it has become with tracking hierarchical steps. In addition, students can become confused about being on the one hand included in the full curriculum, but on the other being told about their lack of, or partial, achievement.

Conclusion

This report of one teacher's practice shows that a *discourse of inclusivity*, focusing on *choice, challenge, autonomy, collaboration* and *learning environments* is possible to sustain, even within the current accountability and linear hierarchical structures of curriculum and assessment. The article is not a review of research into all-attainment groups in mathematics, because the effects of grouping are dependent on teaching methods, and in this article we have focused on describing one particular approach. However, it is noticeable that Gwen's methods relate closely to what has been reported elsewhere (Ollerton & Watson, 2001; Swann et al, 2012) and the difficulties and key features of the way the department works are also in tune with other reports (see www.cmtp.co.uk). This article therefore offers a framework, derived from

established practice, for thinking further about how to extend all-attainment teaching in secondary mathematics.

The positive benefits extend to teachers as well as to students. There are benefits for the teacher in being surprised when students exceed what might normally be expected of them, or get particularly excited by pieces of mathematics that they might not otherwise have encountered. For Gwen, observing children of differing attainments working together using each others' strengths and interests, and helping each other to progress, was very exciting. We are not claiming that this approach is perfect, however. Belper, like many other schools, has a gender gap in achievement wider than the national average in mathematics; one possible reason is that boys have been less able to reach the high standard of self-directed effort and learning that is, in general, achieved by girls. Early experiences of the need for, and rewards of, self-direction, such as those embedded at Wroxham School, might help overcome that difference.

Finally, all students at Belper experience secondary mathematics in rich learning environments, rather than some students being relegated to groups in which there are fewer available learning skills, fewer available mathematical challenges, and possibly less mathematics teaching expertise.

Notes

[1] Also with first names for teachers and no uniform.

[2] The advisory medium term plans have now been abandoned by the coalition government, but many schools still use them through familiarity and perceived usefulness.

[3] All students' names have been anonymised.

[4] APP is a non-statutory advisory approach to keeping records of individual student learning at the level of individual items of knowledge and capabilities, intended to focus teacher assessment on specific learning.

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