

Currently differentiation is a notion which teachers are being asked to attend to. This collection of articles offers some definitions and some ways forward.

DIFFERENTIATION

A working group at BCME-2

A group of delegates to BCME-2 spent three sessions discussing and writing about differentiation.

With a broad title of 'Differentiation' it was important we had appropriate opportunities to make contributions consistent with our existing knowledge, interest and experience. Hence members of the group introduced themselves and outlined why they were interested in the issue of differentiation. It was significant that many of us wanted to 'know what it is', and needed a basic understanding of the concept before we could begin to consider possible strategies to work with it. In an attempt to achieve this we considered the kinds of ordinary social interactions each of us experience every so often.

We therefore set about to create appropriate analogies. In the first instance we worked on the same analogy as an exemplar. The analogy was of a hundred or so people going to see a film. The issue relating to differentiation was that, whilst everyone had an opportunity to see the same flashing pictures and hear the same words, at the end of the film some people may say what a dreadful film it was, others would want to recommend their friends to go and see it and there would be a whole range of responses between these extremes.

In order to have something concrete to work on, each member of the group were asked to write a couple of sentences about their analogy on a word processor. After a few minutes we swapped with another person and attempted to either extend the analogy, make a statement about what was written or ask a question.

Jan

I spent a week in Pembrokeshire recently, cycling with a group of twenty people. The routes were chosen by the people organising the holiday there were always short cuts and 'long cuts' to choose from. I often started the day at the front of the group and within an hour I was always at the back. The only time that I arrived first for lunch was when I was the only person to cut six miles off the route! I sometimes felt that there were

some people who thought I was cheating. My choices were often put down by others (always men). I really enjoyed the cycling I did but I felt I had to be quite a strong personality to withstand the peer pressure around me.

Mike's response

The business of 'cheating' is an interesting one. Defining what cheating is seems important here because it feels that it becomes an issue when there is competition between people. I imagine that as far as you were concerned there were two important issues: the first to take part in and enjoy a cycling holiday with some friends; the second to get some lunch.

Anne

People come swimming for different reasons, from children wanting to have fun with their friends, not necessarily involving swimming, mums and dads teaching their children to swim and those who are serious length swimmers. Some swimmers do not wish to be sociable; they want to swim non-stop and push themselves physically. Whereas others come to enjoy the company of their friends.

Huw's response

What about the non-swimmers? Is the pool within easy access with regard to location, ease of access for disabled? What about safety? Does the pool offer a variety of activities, ie lessons; over 60s; lifesaving?

We then used the swimming analogy to consider issues relating to differentiation. The intention was that we would work with everybody's analogies but in the event we didn't get beyond this one.

We considered what our responsibilities as teachers might be, what strategies we might employ and how we might work effectively within a framework that acknowledged the value of differentiation in the learning of mathematics.

Identifying and defining differentiation

Pupils from different cultures bring with them a wide variety of different experiences, expectations,

perceptions, abilities, skills. They have different amounts of confidence and different attitudes to the subject itself, as well as to the school, to lessons and to the teacher as an individual. They are therefore already in differentiated states. When, in carrying out our roles as teachers, we attempt to 'keep a class together' or 'teach to the middle', we are perhaps not recognising the amount of differentiation that already exists. A key issue is how teachers can use the differences that exist to construct ways of working that enable pupils to use their different perceptions of a situation to broaden and deepen each other's view, and allow everyone to develop. Recognising, anticipating and responding to pupils' differing needs are important aspects. Finding potentially rich and appropriate tasks that cause pupils to develop their skills and raise their awarenesses is therefore a necessary craft for teachers.

Classroom, peer and parental pressures

Some pupils have a fear of classrooms and find it difficult to relate to the subject, their teacher or their peers. Some are seemingly content to 'cruise'. Some work hard because they are interested and keen to develop their thinking or even in order to please their teacher. Some wish to push themselves forward and some wish to go unnoticed. Certain types of peer pressure will create an atmosphere of healthy cooperation and competition to self-improve and some pupils will be an inspiration to others. There are also other types of peer pressure such as ridicule which cause some pupils to underachieve. Conformity and competition are both features of the social constructs of classrooms. Within such constructs pupils have certain responsibilities to themselves and to the group. A role for the teacher is to find ways of causing pupils to value perseverance recognise their responsibilities and set realistic and achievable targets for themselves which conform to and extend present levels of skill. Parents can create a further set of pressures and some pupils are strongly influenced by this. If, however, parents show little or no interest, or even disdain, for education this too can affect the pupil's attitudes. Parental pressure can also affect and pressurise teachers. Positive encouragement for parental involvement can be helpful; giving parents the opportunity to get to know the teacher and to understand the aims of their teaching approach can pay dividends.

Choice and negotiation

Choice comes in many different forms: wide and restricted; open and closed; real and illusory; and Hobson's! Whilst being offered a wide choice may seem to be a way of encouraging pupils to work on the business of their responsibility, too wide a choice can lead to some pupils not knowing where to

begin. A restricted choice may be viewed in terms of 'everyone doing the same questions from an exercise' Or it can be viewed as the teacher cutting down the number of immediate options in order to challenge pupils to think about how certain problems can be tackled: for instance removing some of the options from the menu in Cabri; or only using a restricted set of operations with four 4s to generate as many different answers as possible. Some problems offer pupils opportunities to choose different ideas to pursue, and other problems have a closed and fixed result where choice is non-existent. Offering 'real' choices may mean that some children will choose to opt out and do nothing, perhaps to avoid a predicted sense of failure or to avoid self-confrontation. There is no real choice if a choice is initially offered but becomes severely restricted when pupils do not choose the teacher's own preference. Some children must feel as though they are being offered a camel when everyone else is seemingly using a Porsche. Being asked to do the same kind of calculations that they have failed to understand consistently for the last few years may be about re-inventing failure for some pupils. How teachers deal with this opens up possibilities for curriculum development. Negotiating different pathways with pupils seems to be at the heart of teachers offering choice in order to apply ideas of differentiation in their methodology.

Access

Offering *all* pupils a variety of ways of accessing mathematical thinking is an issue of equal opportunity across gender, culture, ability, aptitude and home background. How pupils are offered access to mathematics will be dependent upon the strategies teachers use when setting tasks. Such strategies include flexibility in the arrangement of the furniture; different types of discussion (whole group, small group, teacher and individual pupil); a variety of tasks based upon a common theme; working individually on a task and then discussing it later in the lesson, pupils working on a common task and presenting their findings to the whole group. Differentiation can be achieved by offering pupils opportunities to work with a variety of resources, such as computers, films, TV, artefacts, practical equipment, calculators and no calculators. Some teachers do not have a mathematically-resourced working area and so it is important to recognise that teachers have different types of teaching opportunities to enable learning.

Quantity, quality and competition

In our classes we have seen pupils racing through a booklet within a scheme or a chapter in a text book in order to be the first to the end. We have also seen them counting the number of ticks that they have been given in their exercise books. This kind of

competition seems to prevent pupils from achieving a quality within their work and within their thinking. Competition when used in this way may be viewed as being counterproductive to sound and effective learning. The issue of pupils achieving quality in their work can be overlooked. In the present climate of objective and measurable end-points there is a danger that quality be devalued and sacrificed for quantity. Getting to the top of a mountain may be a desirable end-point, and yet the journey can be valued in its own right.

Competition between pupils playing a simple game, where the goal is to study a structure within mathematics and share understanding is competition in which all pupils win. Competing with one's own previous best is a useful way of extending horizons and achievements. A crucial role for teachers is to help individual pupils identify their goals and help them to work towards them by asking appropriate questions. The kind of questions and interactions will differ from pupil to pupil. The value of such interactions will depend upon the knowledge that the teacher has of the pupils and upon the quality of the questions and the challenges that the pupils are faced with.

Conformity

Text books and schemes often require pupils to set out their work in a particular way. The setting of such standard ways of proceeding can narrow potential outcomes and, at its worst, stifle creativity and imaginative ways of doing mathematics. On the other hand, it is sometimes important that certain information is given and adhered to, such as when wiring a plug. There can be little room for imagination and creativity here. Teachers have a definite responsibility for deciding when pupils need to be given standard methods and when they need to be encouraged to decide the route themselves.

Confidence

How might teachers cause pupils to gain the confidence to believe that they *can do* mathematics? Offering simple, yet rich, starting points that are ripe for development might be one strategy. Building good working relationships is another, as is valuing contributions from individuals. The way that we group pupils, either within a whole year group or within a class, will affect pupils' confidence and their attitudes towards mathematics. Setting alone does not address or achieve differentiation, and it can create self-fulfilling prophecies. Some pupils gain confidence by being given a text book. For others, the feeling that the complete contents of a text book will have to be mastered can be off-putting; and whatever makes pupils feel comfortable and secure might prevent experimentation and the development of broader perspectives. Some pupils will feel confident with only a minimal

amount of teacher input while others seem to need continual reassurance. Offering challenging problems which help pupils to develop their own thinking is a skill that teachers might identify as a purposeful way of working towards building pupils' confidence.

Departmental support

Within mathematics department meetings, rather than giving the whole time to administration, teachers can support each other and create an identity for the department by exploring a new resource, doing some mathematics, discussing and exchanging ideas, telling each other about their best lesson recently, talking about ideas and starting points that worked well or were not as successful as hoped. It is of course important to recognise that brilliant ideas used by one teacher with one group of pupils can fall flat or have unforeseen pitfalls with another. Some teachers have worries about coping effectively with group activities; it might be helpful to recognise that most pupils have worked successfully this way in primary school.

Creating change

Working with teachers who recognise the importance of differentiation and wish to explore ways of addressing this issue and try out new ways of working, is very different to working with teachers who largely reject change. Teachers who are confident only with teaching methods that depend mostly on published schemes (often text books with setted classes or individualised schemes with un-setted classes) perhaps need encouragement to vary their approach in small steps.

Summary

The essence of this article is that pupils are individuals influenced by numerous people and situations, past and present. In order to help them to develop, teachers must seek to understand their differences, to communicate effectively and to provide a varied diet of mathematics in flexible ways to enable them to achieve their potential. The following quotes provide encouragement to teachers of mathematics to help get to the heart of differentiation.

"Mathematical content needs to be differentiated to match the abilities of the pupils" but, according to the principle quoted from the Cockcroft Report, this is achieved at each stage through extensions rather than deletions. [1]

"Differentiation of content, if well planned, facilitates progression for all pupils." [1]

These statements support a positive approach to a differentiated curriculum, based on pupils' successes rather than on their failures. Viewed in this way a differentiated curriculum enables all pupils to progress as far and as rapidly as their abilities will allow.

One possible model is for the teacher to seek out common yet potentially rich starting points to provide all pupils with their entitlement to access to the mathematics curriculum. There need to be opportunities for the teacher to help pupils to develop a starting point to the best of their abilities and at a variety of different paces. In doing this the teacher offers a variety of ideas and extensions; thus differentiation is achieved by outcome and by task.

To provide equal access to mathematical learning and to enable each person to achieve their potential, independent of race, gender, cultural background and ability, equal opportunity policies must underpin the structure and the organisation of an institution. Ways that teachers work with pupils to cause and use differentiation are inextricably linked to the development of mathematical thinking through active learning and equality of opportunity.

The diversity of pupils' interests and motivations leads us to expect a diversity of outcomes whatever we do. Even the most closely-focused lesson, traditional exposition, for instance, will lead to different outcomes. We should not expect otherwise. Planning should embrace these outcomes and possibilities. In fact, it is understanding differentiation that causes us to meet the individual needs of the pupils within the framework of the mathematics curriculum.

References

- 1 HMI: (1985), *Mathematics from 5 to 16*, Curriculum Matters 3, DES, 1985

Mike Ollerton teaches at Orleton Park School, Telford and the University of Manchester. Jan Winter teaches at the University of Bristol School of Education. Other members of the BCME discussion group were Sue Brazier, Lynne Churchman, Kirsten Hinds, Alan Kennedy, Peter Mitchell, Huw Roberts, Ian Williams and Anne Woodman.

Strategies for differentiation

It is interesting to reflect on one's formative experiences. This can not only illuminate the nature of the influence but also heighten awareness of the existence of possible influential situations. One such experience occurred for me many years ago on one sunny spring morning when teaching a middle ability class of broadly setted 12-year-olds. The topic was on shape and, a few minutes after starting the lesson, in walked a boy I had not seen before and whom I shall call Ben. Assuming him to be new to the school – this happened from time to time without warning – I invited him to settle down, take part as best he could and wait until I could give him the required attention.

The lesson duly proceeded with whole class discussion of the problem to be worked on, small group activity and further discussion and sharing of

approaches and ideas. During these whole class sessions I was struck by Ben's interest, attention and contributions to discussion. He had some good ideas and displayed some geometrical intuition which compared well with many in the class.

It was only after the lesson had finished that I was able to discover that he normally worked in the special needs department and had, that morning, lost his way and arrived in my classroom. Ben's achievement in number was indeed low and that formed the major part of his programme in mathematics, but here was clear proof that mathematical ability is no simple matter, and is not necessarily uniform across different aspects of the subject.

This, along with other experience of working in a more open, less predetermined way, supported a growing personal conviction that it was difficult to judge what young people might achieve, or be capable of achieving, at their own personal level. Differentiation, in the sense of devising work targeted at individuals or small groups so as to match tasks to their ability, had become a problem. What was clearly needed were starting points which enabled all learners in the class to become involved in potentially productive activities and which were capable of development according to need, interest and ability.

Experience with investigative work in the classroom showed that this approach had a number of benefits. Once a suitably interesting and motivating problem had been posed young people were able to develop their own methods of attack, to extend or develop the problem according to their ability, to collaborate appropriately, to pose questions for each other at suitably challenging levels and to become involved in taking decisions about the nature and direction of their own learning. Given such a situation it becomes relatively straightforward, through discussion, to come to joint decisions concerning future work. It is through such processes that learners develop a greater sense of responsibility for their own learning and become more able to contribute meaningfully to the determination of differentiated levels of working within the current topic being explored.

An additional bonus from such an approach is the ease with which it is possible to provide opportunities to develop higher order skills and processes. Generalising, reasoning, explaining and justifying take place in a meaningful and purposeful way with learners more readily appreciating the need for them when asked to convince others of the validity of their findings.

The role of the teacher is different, of course, in classrooms operating in this kind of way and it has to be recognised that not all teachers feel comfortable with the changes in relationships implied. This needs thinking through if a more open approach is

to be adopted effectively.

Given a desire to involve young people more in decisions about their learning, as a way of increasing the effectiveness of differentiation, attention will need to be given to the creation of a suitably supportive climate in the classroom. This is rarely achieved without effort and patience and takes time, but the pay-off is seen in pupils' attitudes and progress.

Alternative strategies for differentiating seem to me to be more limited or even to beg the question. For example, those individualised programmes which see pupils working through interminable pages or booklets 'at their own pace' without their being supplemented are clearly inadequate. Where one individual completes a single-step instruction, which lacks any requirement to engage in thinking or reasoning to a meaningful degree, in November whilst another completes it the following June there is a lack of appreciation of the ability of the first to cope with greater complexity. A simple task remains a simple task, whether it is done more quickly or, within reason, at a younger age. In addition, the use of identical words and sentences to set these tasks to all, whatever their linguistic ability, can hardly be appropriate.

The strategy of setting or grouping by ability, whilst allowing the teacher to feel able to cope more easily, can lead to complacency or misjudgment or, as in Ben's case, unjustifiable generalisation about ability across the whole range of mathematical activity. This is not an argument against such organisation. It merely emphasises the fact that organisational arrangements on their own, with work still targeted at the whole group, will often not adequately provide suitable differentiation for the individuals within that group.

Effective differentiation needs to take account of a number of factors, including levels of difficulty, challenge and complexity, context and interest, together with previous experience and assimilated knowledge and skill. An investigative approach to mathematical topics provides for me the means to explore these factors with young learners and to devise tasks, problems or questions which are more likely to be appropriate to their current stage of learning and understanding. Sometimes these questions will be posed by me, sometimes by the learner and sometimes jointly, but almost invariably arising naturally from the discussion.

David Rooke works as an inspector in Nottinghamshire.

How do you differentiate in your classroom?

Mrs Kelly, as part of this interview, we would like you to tell us how you differentiate within your classroom.

If the school uses an individualised 'scheme', whether a commercial scheme such as SMILE or a home-grown scheme, then differentiation is built in to the teaching method used. But this is dependent on a well-resourced department and a well-qualified experienced staff who are confident with the processes involved. It uses a lot of teacher time to prepare each individual's plan and to monitor what is happening. A new member of staff needs careful preparation in using the system and needs to be monitored themselves to ensure that each pupil is achieving their best. It is easy to become complacent and to think that these plans have worked before, but they may not be taking the individual pupils needs into account and there may not be a coherent theme running through each individual plan. There are problems with such schemes.

In these days of reducing resources this method of educating is becoming too expensive. Pupils need access to teachers for advice, help, reassurance, access to computers and relevant software, mathematical equipment, graphical calculators, paper and miscellaneous bits and pieces. One teacher with a class of 32 quite bright demanding pupils who might be working through plans at the rate of one a week, is going to be put under unwelcome pressure. A teacher is going to begin to feel that being responsible in that particular situation is more like being an administrator. And what about the pupil? Where is the variety of style? Where is the time to work as a member of a class? Where is the time to work in small groups? It is fine to work on one's own, but people are social creatures and a great deal of learning is done by working with others – explaining the thinking that each person goes through and arguing over sometimes quite trivial points. Yes, in coursework activities there may be time to use these other skills, but mathematics is such a rich subject that we should encourage a wide variety of approaches in as many of our lessons as is possible.

What about the school that is locked in to a text book scheme such as SMP or UMs? They may also be the type of school that has a staff of three of whom only the HOD is a qualified mathematician. Here differentiation becomes extremely difficult. Again with a class of 32 bright youngsters, four or five can have finished a chapter, say on negative numbers including some quite complex algebra, whilst at the other end of the ability range five or six are still struggling with the concept of subtracting one negative value from another negative value, and the syllabus says that next week the whole class should be studying gradient. An inexperienced

teacher or even a non-mathematician may generally continue to plough on regardless of what is happening to the students in the class. However, this is where the OFSTED inspections are drawing attention to this notion of differentiation. Heads of Department up and down the country are addressing the problem, but are they really solving it? What do you do if Mrs X only comes in to cover two classes and has strong views of a traditional nature that includes children working in silence, never interrupting her, never discussing their work? Or what about Mr Z who is a Senior Teacher and was teaching mathematics before coursework and does not have the time to really understand what it is about, despite being a very caring teacher. The problem of staffing a mathematics department is quite crucial and has implications for differentiating. With dedication, interest and a good all-round knowledge of the subject, ideas can be put together that can be used to allow pupils to develop at their own rates, within reason. But I would hate it if mathematics became so prescribed that the individual teacher could not input their own ideas.

This raises another issue: that of time. No teacher at the moment, in any school I know of, has time. The department meetings only happen once a month with perhaps informal discussions taking place more regularly. There are other priorities, such as the personnel group, year meetings, policy-making groups and full staff meetings. Teachers are human and do belong to society and should have a life outside the classroom.

As a classroom teacher I see the answer as being one of compromise. I want my pupils to achieve the best that they can, with full understanding, using the best methods that I can provide. Different pupils respond in different ways and it is up to me as their teacher to allow them to experience as many alternative methods as is possible, to be able to develop the maturity that is necessary to work on their own, to enjoy sharing ideas, and to enjoy their mathematics. The way forward that I envisage is that we should be given time to examine the constraints that the NC has put upon us, to work with those and the texts that the school has, together with the personal ideas that the teachers have, to develop a scheme of work that can take in each individual's needs, yet use all the divergent methods discussed before. It will be long-winded to start with, but like any new development it will become quicker with practice. Then the pupils can benefit from a more coherent scheme than say doing negative numbers one day and gradients the next. And teachers will have time to teach the class as a whole, to work with individuals and sometimes to just talk and get to know their pupils.

A structure for planning differentiation

What is differentiation? In trying to give my answer to this question I searched through a number of reports, wrote many lists, scrunched up many lists, and finally came up with my flower image. This, I feel, encapsulates my sentiments regarding differentiation in mathematics teaching: a delightful structure dependent on variety, not always necessary, but very pleasing when it comes to fruition. The central petals show the key areas, at least some of which I feel need attention if a differentiated learning activity is to take place. The outlying petals depict just a few examples of each area. The rest is self-explanatory, although the buzzing pupil with sting could be open to debate! I eventually arrived at this image through analysing a few recent projects that I have run in school and which I felt allowed differentiation to occur.

Following the flower and its research I set about trying to find common links in the ways that I had planned the various projects. My aim was to arrive at some criteria for use in planning future activities. Some ATM group input helped me to hone my ideas. Whilst I do not think the resulting nine point structure is exhaustive, I am now using it to build a more complete model and am happy to share this first draft, along with just one example of a series of differentiated lessons which I hope will clarify its meaning.

I have chosen as my example the series of lessons that resulted when I presented the following problem about magic squares.

Arrange the numbers 1 to 9 in a 3×3 square, so that each row, column, and diagonal adds up to the same total.

1 Start from topic with ideas about possible extensions

I was addressing the broad area of arithmetic with a Year 8 group and presented the 3×3 magic square, with my own insights that symmetry, reflection, rotation, types of numbers (odd/even/negative/etc), multiplication and powers were also very likely to be relevant.

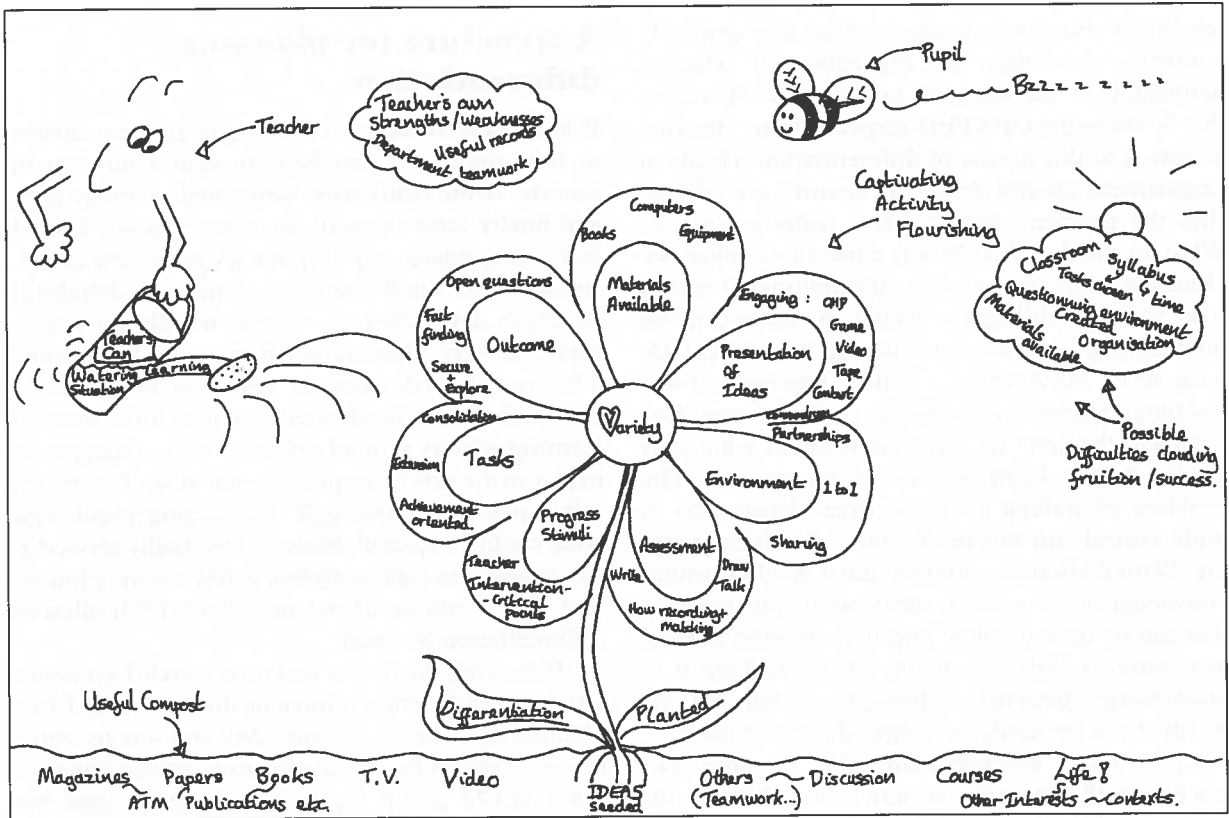
2 What do they know?

The Year 8 class were familiar with some number types, although I also used this activity to ascertain who knew about negative numbers, powers, and so forth.

3 Offer something engaging

The magic number squares idea came from the Bristol Exploratory Maths/Puzzles section. I knew that this group had visited the science section and enjoyed the style of activities there. So I gambled that they would 'bite' at this too ... they did!

Susan Kelly teaches at Longford Community School, Hounslow.



4 What input would I give?

How focused do I want it to be?

I chose to interject with hints and prompts throughout, (such as verbal, on the board, one-to-one) to help pupils overcome specific difficulties. My main prompts were: Is there only one solution? Sum is 15. Try other types of numbers. Can you predict the line sums? Are all methods the same? Are all sums possible? I wanted pupils to find the diversity in this work.

5 What about the non-starters? fast track? near misses/wrong turnings?

To help everyone begin I allowed pupils to work in pairs. They made nine paper squares with numbers on, rearranged them practically and recorded only the final solution. I summed up at an appropriate juncture, with discussion and feedback.

Those on the fast track were invited to find general rules and to solve their own problems. This task was so open-ended that the pupils did not seem to stall.

I was able to detect wrong turnings reasonably well through one-to-one work and class discussions. Sometimes pairs of pupils detected wrong turnings for themselves.

6 Variety of resources

I provided squared and plain paper, scissors and glue. Text books describing different number types were on hand, and calculators were allowed for work with big numbers.

7 Tactics for allowing diversity

I placed the resources on a table, at the front and drew attention to them at the start of every lesson, which removed the need to spend time issuing items. The starter questions I provided seemed to help everyone to get going at the beginning of each lesson, and several discussions served to keep the momentum going. Thus, as the majority of the pupils were busy, I was able to work frequently on a one-to-one basis. Regular hints and links pointed out by the pupils and myself, and shared with the class, helped to focus the activity a little and gave me a clear insight as to just how diverse the activity was.

8 Valuing a range of endpoints

I deliberately set out to allow verbal feedback, as well as written or diagrammatic, in order to give opportunities for different forms of delivering solutions and findings. I based my assessment on how individual pupils had progressed, and what new steps they had taken, rather than on any absolute measures. I used comments and effort grades, and not numerical marks.

9 Where do they go next?

I gave them a grid which I entitled 'A More Powerful Magic' as an extension. This opened up a debate on multiplication and powers ... So the next step became obvious!

This nine point structure provoked some debate in the ATM working group on differentiation, and I would like to add just a few points. Simon Pennifer pointed out that another essential ingredient was:

'At some stage pupils must work independently'.

Whilst not explicit in my structure, I would agree that the chance for this needs to be implicitly woven into the planning of a differentiated activity; My example above certainly allowed this. I very much think that a successful learning activity must enable the pupils to make independent steps forward. On this theme, I feel that looking into differentiation has been a learning activity for me. My next step forward is to pick a random activity and attempt to use my structure to plan it. Hopefully I will end up with a series of lessons which enable differentiation of learning of mathematics to occur for the pupils.

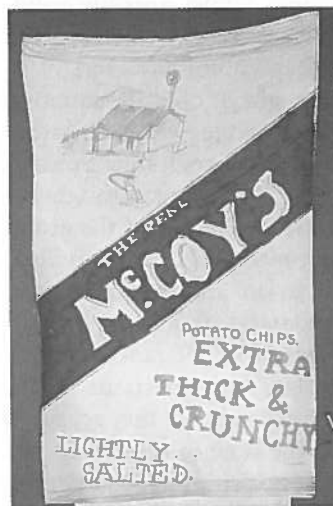
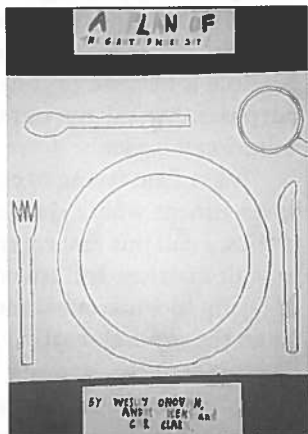
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The giant's hand

'Something really interesting happened to me at the weekend. I met a giant! I'm not sure exactly how tall she was but she was much bigger than an ordinary person. She took me to her house where everything was bigger than usual so they were the right size for her. Look – she gave me a photo of her hand to prove it. This photo is exactly the same size as her hand is.'

So began a short series of lessons with a Year 7 class. We began by discussing what we could find out about the giant from the picture of her hand (reading her palm was suggested!). I asked the class to write down some ideas of things they could work out. How tall was she, how big was her furniture, how big was her car, what size were her plates and cups, ...? By the end of the lesson a whole range of possibilities had been suggested and shared. Some children had been rather sidetracked by their fascination with whether the story was true or not. They set to disproving it with the tenacity of an Inspector Morse. I was presented with a list of evidence to suggest that the whole thing was a fabrication and that in reality the giant's hand was simply my own, enlarged on a photocopier. It's a fair cop! The small freckle on my first finger was the clinching evidence. Once I had owned up the detectives turned their attention to the task in hand.

Next lesson the measuring and estimating began in earnest. 'Her hand is 25cm long. My arm is 3 times as long as my hand. So her arm will be 'bout 75cm long.' The room was full of children lying on



What had the pupils been doing? They had been measuring, estimating, using ratios, scale drawing, approximating – and that doesn't begin to consider the wealth of activity in using and applying their mathematics, nor the collaboration and group work they were all involved with.

Differentiation? The variety of activity which happened in the classroom was enormous. Pupils were making their own decisions about what aspect of the task they wanted to pursue. They were working in a variety of mathematical areas and tackling the necessary calculations with a range of techniques. There was a lot of sharing of ideas and learning from one another. The teacher was there to advise and to be a resource to draw on when developing particular lines of thought.



Jan Winter works at the University of Bristol School of Education.

What would it be like not to differentiate?

As one of the convenors of the ATM working group on differentiation I have been much exercised by a comment from one of the members of the group: *what would it be like not to differentiate?*

Well, my initial response, and one that I'm going to stick to, is that it's impossible not to achieve differentiation in the classroom, no matter what you as teacher decide to do. Each child is in the position of engaging or not engaging with what is on offer, and their thoughts are going to be dependent upon what they have learnt, experienced before and what their attitudes are to the subject, this lesson and the

floors or standing up against walls while others buzzed about them with metre rulers or tape measures.

After four lessons a giant had been constructed from sugar paper and numerous pieces of household equipment (including a bowl of cornflakes for breakfast) drawn or constructed full size.

teacher. This point of view, whilst possibly valid, did not take me any further in my own thinking about the subject of differentiation, however!

So, what might be an image of differentiation that I might feel uncomfortable with? Consider stereotypical lessons where teachers follow through their own agendas and plans (getting through the syllabus?) as independently as possible of the group of pupils they are working with. Either an individual pupil 'understands and can do' and therefore has a choice of whether to demonstrate this (easy, boring) or an individual pupil doesn't understand in which case the choices are similar. Any questions would put the teacher off course and so the accepted behaviour is just to pass the time in some way and try to keep a low profile (day-dreaming, sharpening a pencil). After the lesson a motivated pupil might go away and enlist support in trying to understand and work at the ideas presented, whilst an unmotivated pupil won't necessarily pay it all another thought.

The essential thing about strategies for differentiation which I feel comfortable with is that the individual pupil in the classroom becomes part of the planning for the lessons. This might be achieved by having a range of tasks to be tackled, or by the work being set up in such a way that the pupil can be challenged to sort out some aspect of mathematics which could easily be different to that challenge being accepted by any other member of the group. This does not necessarily mean that the task is 'open' in the sense of being a licence for everyone to do whatever they please. It is more that the activity is broad and yet focused enough to provide the motivation for each child to want to engage with it. Further, if they find that they haven't yet sorted out some aspect of mathematics needed to solve the problem they are then in a position where they can attend to that. Because of need a pupil may be working at sorting out multiplication for the first time within a far broader context: the breadth of the context will enable other pupils to focus on something quite different if sorting out multiplication is not their need.

In thinking about one of the strategies which a teacher might employ to achieve this particular form of organisation I have started to use the phrase 'spurious purposes', following a recent meeting (facilitated by Heather Scott) in Northampton and after working there with Alan Harper and Sue Briggs. Pupils engage with some task or challenge that is at a distance from any particular moment of the lesson. This task becomes the pupils' purpose and is real to them but is distinct from the teacher's purposes which may or may not be shared with the pupils. These examples of spurious purposes developed out of the discussion at Knuston Hall:

– SATs are coming up after Easter and when you come back after the holiday you will have four

weeks to work on preparing yourselves. Write me some brief thoughts about where you'd want to begin working and I'll prepare some possible references and materials that might support your work.

- addressing an area of the curriculum or part of the syllabus eg a theme of curves (for a term?)
- completing a piece of coursework
- preparing a unit of work for another class
- being asked to go in to a feeder primary school to do some work with the children on ...
- setting up projects which link in with local businesses eg packaging problems, decision maths tasks, ...
- helping out with the school summer fete in preparing games of chance which will make money but not too obviously
- linking in with FE provision to take advantage of the FE workshop resources
- residential experiences
- review a suite of computer programmes and produce a manual
- prepare a booklet for exchange pupils in their language which gives them costed options of what they might want to do with their time and other useful information to introduce them to the local community and culture with special events and trips
- pursuing pupil-generated ideas.

Not all the ideas we came up with are listed here but the more we worked at this idea the more possible it became to invent them. Some are larger purposes than others, but they all have an element of what I call 'space':

'What I am trying to create in my classroom is an environment where children are working at mathematics. I call this environment a 'space'. Sometimes, as with matrices and transformations (the challenge of trying to work out what effect a , b , c , and d have when the general matrix

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$$

is used to transform a shape), almost the whole of the mathematics syllabus is in the space and at other times, as with the nine-pin geoboard activity (finding how many different triangles on the board), just particular ideas eg area and drawing skills. I know when I have found a space, for as long as the motivation lasts, because the children are busy working – challenged, asking and answering their own questions and finding ways of making their ideas clearer to themselves by thinking them through. The 1089 lesson I use with classes early on in their school career because I have confidence in my way of operating with this idea in trying to establish my way of working. Always there is the process; always the problems, questions and ideas providing the thrust for the activities even when I am being focused about the content.' [1]

The thoughts from Northampton have enabled me to develop my view of my teaching that was

shared in *In our classrooms*. There is now the feeling that instead of looking for the spaces or knowing when I've found them, I've a story that can support me in the finding. The purposes are called spurious quite simply because they are there to provide a vehicle through which time is built in for the work on what the pupils need to sort out to be done and also because that purpose, so useful for motivation, may be different from the teacher's purpose.

There is still the issue of 'take-up' and selling the idea to the children but at least I've got a framework within which to think. After returning from Northampton I was reminded, by reading *With hindsight* (Education Guardian, 07/03/95) about the book Kes which tells the story of Billy Caspar. 'Everyone calls him thick, then he finds something which motivates him. He struggles through difficult books and masters a complex art – falconry. All right, he didn't have great job prospects, but at least he'd discovered kestrels and that was a metaphor for saying that people can discover things in their lives'. It's certainly harder to discover things if there is no sense of purpose. How can we recognise and work with such purposefulness in our pupils?

References

- 1 *In our classrooms: strategies for the teaching of mathematics*, ATM 1993.

Laurinda Brown teaches at the University of Bristol School of Education. She would be interested to hear from anyone who plays around with the idea of 'spurious purposes' as a mechanism for planning. If you are not trying to keep all the children artificially together what are you doing instead? Any writing can be sent to Laurinda through the ATM office.

Mind the gap

At a meeting of Shropshire heads of mathematics in April, discussion briefly strayed onto issues of setting in the secondary school compared with the usual practice of having un-setted groups in primary schools. This resulted from input by a primary advisory teacher whose main responsibility is mathematics.

One head of maths said that because of pressure from a parent, his head teacher had put pressure on him to move to setting in Y7. The other heads of maths were then invited to describe at which point they setted their pupils and, apart from one department which stay un-setted up to and including Y9, with 'some' un-setted groups in Y10 and Y11, and my own which stays un-setted throughout from Y7 to Y11, the majority of departments created sets in years 7 and 8.

I commented that the principles for not setting students in Y6 were the same as for not setting in

Y11, and questioned the morality of creating apartheid groups. This largely fell on stony ground, although there was one response which was that as pupils get higher up the school, the 'gap' gets wider. This comment stayed with me and after the meeting I reflected upon what 'the gap getting wider' meant and what the implications are for teachers. It seems to me that setting occurs because teachers have difficulties working with pupils who have a wide range of different interests and potential achievements. Setting is about drawing lines and predicting who will be first and who will be last. A verse from Bob Dylan's *The times they are a-changin'* comes to mind –

*The line it is drawn,
The curse it is cast.
The slow ones now will
Later be fast,
As the present now
Will later be past
The order is rapidly fadin'
And the first one now
Will later be last, For the times ...*

This notion of an ever-widening gap opening up between the strongest and weakest mathematicians seems to be more descriptive of a group of people setting off on a mountain walk. Using this analogy, the party will usually set out from the same place and head for the same destination. For safety they will largely need to be 'kept together'. As a teacher who has taken many parties walking, I have experienced some children wanting to dash off in front whilst others have had neither the energy nor the inclination to keep up with the pace of the fastest. As a result they tended to dawdle along at the back and as time progressed the gap between front and back became wider. Those at the front were constantly being asked to wait and I sensed their frustration grew as those at the back seemingly went slower and slower. I am sure that teachers who have taken walking parties will recognise this tension.

I wonder how many mathematics teachers feel the difficulties of working with children who have a wide range of potential achievements are similar.

In my mathematics classrooms I do not worry about the 'gap' because I do not expect to keep my class together, nor do I expect all the pupils to reach the same destination. Indeed, to set out to achieve either of these outcomes is to deny the differences which exist. Consequently much of my teaching will be didactic, about 'telling', and driven by narrow exercises which focus mainly on the acquisition of narrow skills. All classes have a range of potential differences and 'gaps' and the issue is not therefore how I operate with a large gap, but how I operate with any gap whatsoever. My responsibility is to devise strategies to work with the differences that exist in the pupils; I must work on issues such as

differentiation and pupils' personal responsibility for their learning.

So what are these strategies? What kind of lesson plans can I devise to support learning in un-settled groups? Whilst I still use many of the excellent ideas in *Starting points* (Banwell, Saunders and Tahta) together with the 200+ types of 'open' starters that can be found in the ATM publications *Points of departure* (1, 2, 3 and 4), I also plan sequences of lessons that focus more specifically on developing or consolidating several content skills whilst simultaneously drawing upon process skills. For example, a lesson that begins with nine-pin geo-boards and the task of finding all the different triangles can create opportunities for work on content skills such as: naming shapes, area, symmetry, angles, measuring lengths and perimeters, and process skills of systematizing and proving. My best planned lessons are those that provide this kind of range of learning experiences for pupils who have a wide range of interests and aptitudes.

I am planning to give a Y9 group, that I am due to teach, paper with four circular grids with sets of five, six, seven and eight dots equally spaced around the circles. The initial task I shall set will be to find all the different shapes (not counting cross-over's in the first instance) that can be made on each of the grids. Depending upon how adventurous I am feeling, I might invite, say, five pupils to sit in a circle with a long length of elastic and ask them to make some of the different shapes. I shall ask questions about angle sizes in the shapes they make and there will be opportunities to do some work on angles at the circumference of a circle. I am aware that there is a connection between the numbers of triangles (congruent ones included) for different numbers of dots and a number sequence in Pascal's triangle, but for the train spotters amongst us (with or without feelings) it is not 1, 3, 6, 10 ...! So, whilst planning doesn't go any further at the moment I can intuitively feel that other ideas will develop and I expect to use words such as congruent and other vocabulary associated with shapes, angles, angle sums and circles.

By the time that the 'topic' is finished, and this will largely be determined by whether the work is going well, or going down like a lead balloon, I expect that different destinations and different understandings will have been reached by different pupils. Whilst they will be starting off on the same task, they are not all starting off with the same knowledge and so differences will exist at the outset. How 'far' an individual pupil takes the mathematics will be decided partly by that individual's desire to develop the work and partly on my craft as a teacher to promote an interest in the task. Because I know the class I can almost predict the types of events that are likely to occur. For instance, Ian will no doubt be crowing about Liverpool FC's success in the

Coca Cola Cup Final; I expect Amy to continue to make the kind of progress that I have seen her make over the past few months; Matthew will work hard if the idea takes his interest; and Mandi might, on the surface, feign disinterest and yet will undoubtedly work hard. What I am not able to predict is how far any of them will develop the work or the depth of understanding that will occur inside each of their heads. I shall have some expectations, but there will be surprises, and some pupils will work in ways different to how they have worked before. I can predict with 100% confidence that there will be a wide gap and variation in work rate, effort, achievement and knowledge.

To enable my pupils to work on their mathematics, whatever the content, I do not need to segregate them out into notional 'ability' groups, because this would be for my convenience. I do not need to 'keep the class together', and if I do then my focus will be more about the pace I can teach at rather than the different paces my pupils learn at. By doing either of these I am more concerned with my needs than my pupils' needs. My responsibility is to construct a range of strategies to help them fulfil their needs to develop their mathematical thinking.

A key ingredient is finding a place to start from. The same starting point, providing it is both simple enough in the first instance and has plenty of scope for developments, will serve all the pupils. I will have some potential extension tasks to offer different pupils at different times, but what actually happens in terms of the type and the intensity of discussions that I shall have with individuals is an unwritten script – which is what I believe makes teaching and learning so interesting.

Mind the gap might be a useful phrase to remind British Rail passengers not to fall down a hole, but it is not a phrase that ought to cause departments to predetermine and pigeon-hole each child's mathematical potential.

Mike Ollerton teaches at Orleton Park School, Telford and the University of Manchester.

What do the pupils think?

Beliefs about mixed-ability teaching are deeply held amongst various adults involved; teachers, politicians and parents. However, as usual in education, when do we ask the young people concerned? Pupils at Longslade Community College seemed to me to be in an unusual position in that having been set during the middle years in their high schools, they move to an upper school with a policy of mixed-ability teaching in mathematics throughout years 10 and 11. That their experience is in the reverse order to most, and having the maturity to compare the two, prompted me to undertake a short piece of research (using a questionnaire) to resolve for

myself the method of organisation preferred by the pupils.

The school has a broad catchment area and a record of sound academic success. The mathematics curriculum is task-based, with pupils following the same topics at different levels depending on expected entry at GCSE. It is intended that by following the same 'work' to the appropriate depth, all pupils have access to the entitlement curriculum.

Believing that there are many factors to consider, the first section of my questionnaire consisted of twenty statements covering ten aspects of the learning process, each posed from a positive and negative point of view: personal preference, perception of own ability and progress, differentiation within the curriculum, attitude to learning, preferred style of learning, comparison with the middle school, effect on the high and low achievers, teaching methods and the success of the teachers in managing the curriculum. Possible responses ranged through strongly agree, agree, not sure, disagree to strongly disagree. I randomly selected 100 pupils, fifty from Y10 and fifty from Y11.

The single statement producing a notable response was:

'On our table we help each other whatever level we are on.'

with the agreement (or strong agreement) of 83% of the pupils. No other statement came near this, the next, with the agreement of 71%, being:

'It does not matter if groups are set or not, I still have to learn the work for myself.'

Education is more than the simple transmission of content to the young, and the pupil-centred style made necessary by mixed-ability groups appears to encourage a positive attitude to learning. However, this is at a significant cost, for the statement eliciting a similar response (with 65% agreeing) was:

'Because everyone in the class is working at different levels, we spend too much time working from books.'

There were only two other statements which produced this degree of consent:

'If the classes were set then we would be all on the same level, so the teachers could teach everyone at once.' (62% agreeing)

'It was better in the high school, when we were put into different sets.' (60% agreeing)

One might argue that the former is simply a factual statement, with which it would be difficult to disagree, but the latter is a clear indication that if pressed for an opinion, setting is the preferred style.

No other statements produced responses of any significance, leaving us wondering what can be said at this stage? Clearly the pupils believe that cooperation is very important, and the overwhelming majority see this as part of the learning process. Furthermore, they see the emphasis on themselves as autonomous learners, but at the same time

recognising that the teacher has many roles to play in the classroom, some of which are not being fulfilled as expected.

These views were often amplified in the second section, the open-ended questions. The first two questions asked 'What are the advantages (disadvantages) of having mixed ability groups?'. As may be expected from the first section, the notion of co-operation, as expressed in a variety of ways, was by far the most popular response, given by 47% of pupils.

'You can ask other people for help.'

'Your friends can often explain things better than teachers.'

'To learn from other people.'

This was largely seen as a one-way process, with the more advanced helping the rest. Although this could be seen as a disadvantage, it was only mentioned as such by two pupils – spending time with those 'having trouble'. The second most popular response referred to being with friends, cited by 18% of pupils.

The principal disadvantage of mixed-ability groups was the effect it has on the teaching process; 49% of pupils mentioned difficulties regarding the allocation of the teachers' time. Problems such as lack of teaching to the whole group, or sub-groups, or individuals, were the most common. Furthermore, it was largely felt that it was the weaker pupils who suffered in that a disproportionate amount of the teacher's time was devoted to the 'brighter' pupils – only 12% thought that mixed-ability 'held back' the more able.

The final questions, 'What are the advantages (disadvantages) of setting pupils?' produced replies that usually complemented the first two questions. So the main advantage of setting was that it clearly helped the teaching process, with 36% of the pupils remarking on the advantage of having pupils either working at the same level or the same speed. A further 16 mentioned teaching: class teaching, faster teaching, better teaching. As one pupil said:

'They can be taught more easily and more efficiently.'

The major disadvantage of setting was very clear in that 49% cited problems of being in the bottom sets. Those in the lower groups were seen as having no chance, of experiencing shame and embarrassment, of being laughed at and of feeling 'thick', of being left out by friends, of being denied access to the full curriculum, and of having no one to turn to for help.

'Lower ability pupils in lower sets are not given a strong incentive because they think they're no good.' 'Some may have their confidence shattered because they feel they are thick if they are in the bottom group.'

In addition, a further seven cited the predicament of being in the 'wrong' set, or of being on the

borderline. The only other significant disadvantage to emerge was that of being separated from friends, noted by fourteen of the pupils.

Had one been preparing a defence for either side, one might have hoped for a clear mandate. However, this was simply not the case; pupils do not see setting/mixed-ability as an issue. They clearly see the advantages of individual and group working, and of being in the same group as their friends, but contrast this with the lack of formal teaching and teacher attention, and the over-reliance on written resources. Clearly, within a setted environment, individual and group working could continue, with the added benefit of 'efficient' whole class teaching. However, to create sets means separating friends, and generating 'bottom' sets, creating problems recognised by the majority of pupils.

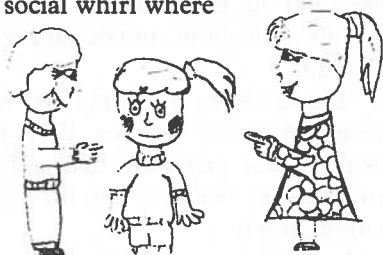
The way forward? In this case Longslade decided to set, retaining much of the pupil-centred approach but with a good deal more teacher input, while bearing in mind the enormous problem of 'ability stereotyping'. But then again, every school is different.

Colin Billett teaches at Kidderminster College. When he wrote this he was teaching at Longslade Community College, Birstall, Leicester.

With a little help from my friends

This is it. Teachers face it the beginning of every school year. Soon our pupils will flood in, bringing with them a myriad of experiences, abilities, and yearnings. Our job is to get them involved and relating to their own learning. Taking responsibility is what it's all about. Not for us. For them. It's important for pupils to start talking about, thinking about and becoming involved with their own learning. So, I wonder, what is the best way to help them? Several years ago, I was going over my class list, preparing for the next unit in my class. As I reviewed each pupil it seemed I'd had these kids in my classes every year for all the years I'd taught. In every grade Kindergarten to Sixth, I'd met them before, worried about their progress and planned activities designed to bag their interest, involve their skills or allow practice for their needy areas.

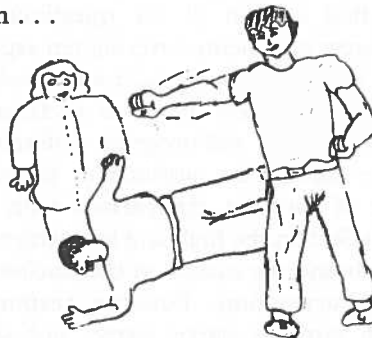
There are Betty and Barney Busybody examining everyone's clothes, habits and possessions. For them, school is a social whirl where the greatest concerns are what to wear and which one to talk to next . . .



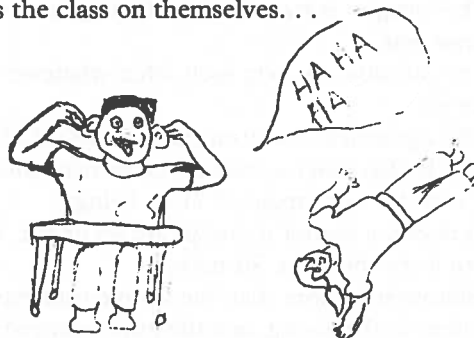
John and Jenny Jock the goalie, pitcher, slam dunker; they give high fives, and cheerfully bump into each other and everyone else as often as possible. . . .



. . . Raquel and Randy Rowdy respond to every accidental bump or suspected slight with a kick, punch or a push. For them, school life is a round of watching out for themselves and making sure to get even . . .



Fran and Ferdie FunnieFace, the class clowns. No matter the topic or timing, they'll do anything to focus the class on themselves. . .



Nigel and Nellie Nervous are never sure they could be right about anything. They constantly pull on my sleeve to ask, "Is this what you want?" They want reassurance continually. Learning for them is a fearful thing, full of the pitfalls of error . . .



Larry and Lena Loner standing outside of the usual interaction and conversation of the class; always watching, never really a part . . .



Ami and Artie All-the-Answers are the first with every answer. They have their hands in the air before I ask a question; even when I haven't asked a question. If I don't call on them – first – they shout out the answer. After all, no one else needs a turn. Ami and Artie know!



But wait a minute, isn't all of this just stereotyping? Have I ever really had these kids in my classes? Well, no and yes. None of my pupils has ever come to my classes as only one of these personalities. All of my pupils have been very complex involved individuals. They've had various strengths, limitations, knowledge, interests, concerns, skills, needs and wants. Sometimes this very complexity makes designing an effective curriculum seem an impossible task.



I had, however, experienced that *déjà vu* when meeting new pupils each year for the first time. I knew that I had been here before. That child with the too big dress, the grinning freckled face, the serious one, the boy or girl with the clouded eyes. Somehow, it seemed, I had met them all many other years. I knew, from experience with their previous incarnations, quite a lot about what would work for each of them. So I decided to simplify. I planned the unit with Randy, Lena, Artie and their friends in mind. I liked the results. Many activities, materials, tools, methods and resources I might otherwise have overlooked, I used with good results. Now I often plan a unit with my young imaginary friends in mind.

At the beginning of a topic, while the class discusses ideas everyone will be right. I set up expectations for the way a brainstorming session will go. Respect for one another is the key. Everyone takes a turn. Everyone is expected to listen while other pupils talk. I ask, "If children don't listen to other children, who else will listen?" What pupils say to each other is just as important, maybe even more so, as what teachers say to pupils. All children need to speak and all need to listen. In this discussion there are no really wrong answers. Every pupil will have a turn. Ami and Artie have a chance to talk, but so does everyone else. All ideas are considered valuable even Ferdie's silly ones. I twist these a little to suggest a possible way to do the topic. Ferdie might shout enthusiastically, "How many pages are there in all the books in the world?"

I say, "Wow, that's an interesting one. I wonder how we could find out?"

"That's easy", yells Ami. "By counting them."

"There's lots of books just in our class. I wouldn't want to count all those pages", responds Betty.

Everyone soon sees how difficult that would be.

So I ask, "What other way might we be able to get information of this kind when we can't just count?" Someone may even suggest estimation, but if they don't; I do. After all, I'm the teacher. I get to have an agenda of my own.

In a later discussion, they can make suggestions for each other about people to contact, activities to try, books to read, and television shows to watch and methods of recording the raw data.

We often sit on the floor in fairly close groupings – sometimes circles – to facilitate listening and increase awareness of each other. One person speaks at a time. I often ask pupils to paraphrase each other's comments. It's not possible to paraphrase another person without listening to what has been said, so pupils have to listen more carefully. Much more important is that they have to think about what another pupil says. Thinking about what others say makes pupils build a meaning of their own. Hearing what another pupil thinks he or she means, makes a pupil think more about his or her own meaning. The group as a whole gains a better understanding. Pupils stay more alert. I get to know what Betty and Barney are thinking when another pupil talks. Thinking, creating personal meaning and responding to that meaning are interactive listening skills. Soon, pupils piggy back thoughts onto other pupils' suggestions almost automatically.

I ask pupils, like Larry and Lena, who infrequently comment, direct open-ended questions which will require thoughtful answers. Larry may say, "I don't know".

Then I reply, "Okay, I'll give you a few minutes to think. I'll ask you again in a little bit." The rest of the class can get on with the discussion, but I do return to Larry. "Are you ready with that idea, Larry?" I have given him time to think, but I didn't let him opt out. I sent an even more important message, 'Larry, what you think, matters'.

The general attitude about discussing mathematics is enhanced. Throughout the year, we will reap many benefits from this beginning. Later I will begin discussions with such questions as:

- What does zero mean?
- How many ways can we write the number 10?
- What can you find out about this pyramid?
- Is there a way to discover how many jelly beans are in this jar without counting them?

I admit I unashamedly orchestrate many of the discussions. 'Like a piece of music, the classroom discourse has themes that pull together a whole that has meaning. The teacher has a central role . . .' [1] I redirect questions, choose provoking topics, ask for pupil opinions and guesses, make deliberate mistakes for pupils to catch, play dumb so a pupil needs to explain and find the humour in many situations. While limiting my own contributions to discussions to necessary information, in my talk-show host role, I shape the discussion in the way I have planned for

pupil learning to go. I usually end the discussion with another question.

- What other discussions could we have about numbers other than zero?
- How do people in other lands think of 10?
- What other objects we can investigate in the same way?
- Would our methods work if we were talking about water in the jar and why?

The goal is to excite every child's imagination so the discussion can continue. Soon, pupils will begin making up the final questions after the class ends.

I plan small-group discussions where pupils talk about their progress and get help from each other. This gives Nellie and Larry a chance to shine and encourages Randy and Raquel to solve problems by other than physical means. In individual consultations, I review each pupil's work and make suggestions or help pupils look at the work in a different light. Many pupils have no idea how to assess their own work. When Nigel and Nellie need reassurance, I ask, "What makes this a good graph? How does your use of colour make this presentation easier to read?"

'When you used the database, what were some of the things you learned?' 'What will you tell another pupil about using a microscope?' Ami and Artie need to think before they answer such questions. Encouraging pupils to take a critical view of the resources they use makes them more readily accept the need to test for error, in their own and others work. Independent of the area of study, I want them to question the accuracy, veracity and completeness of the information received from their sources. Ami and Artie revel in pointing out mistakes. Raquel, researching pupils' favorite toys asks, "Why did the toy store manager say girls don't like model cars?" Randy must resolve the problem of finding two different numbers for the population of our school. Nigel and Nellie gain because they learn that everyone is wrong sometimes.

Pupils present to the class work they have done. Often we have a class share fair where the schedule allows pupils time for their presentations and time to view each other's work. Because not every pupil will be able to hear or see all of their peers' presentations, I ask each one to prepare a written explanation to go along with the display. Rather often John or Jenny will want to give a physical demonstration of some sort. I videotape these so that all may see.

My imaginary class does resemble my real one in many important ways. This resemblance makes it an extremely useful tool for me when planning units, lessons, and classroom environment. Most important of all is the imagined interaction. Randy, Lena, Betty and the bunch help me to create a conjecturing community for mathematics and other subjects in my classroom for my real pupils.

Reference

- 1 National Council of Teachers of Mathematics: *Professional standards for teaching mathematics*, March 1991.

Sandra Abernathy teaches elementary pupils at the University of North Carolina Laboratory School. She is also a member of the National Council of Teachers of Mathematics.

Is differentiation helpful?

Having to adopt the term differentiation seems to position me within a discourse that does not adequately describe my practice. It is clearly a discourse that comes from a concern for the achievement of our students and one that comes from a pedagogy of diagnosis and remediation. It seems to me that the avenue of identifying the needs of each individual and then providing appropriate work is bound to fail but is also fundamentally flawed in current notions of how children learn mathematics.

An idea often quoted to me is a reminder of the power all of us had as learners, when we were babies – we all learned to speak our mother tongue and to walk (we were not taught).

'Most grown children no longer practice the powerful learning skills they once utilised so well, the very skills that enable them to be on top of things.' (Caleb Gattegno, 1968)

Our department at CHHS over the last few years has been visited by groups of Hungarian students and their tutors. Their system is a mixed-ability one. Recent visits from British tutors have brought back stories of impressive competencies from all their pupils. Simplistically there seems to be relatively little attention paid to the 'least able'. The groups are asked to work on demanding problems and lots of time is given over to discussion. An immediate concern of the British party was 'But what of the least able?' – 'But all our least able do better than yours, for all the attention you pay them', was the reply. This reply certainly resonated with me. For all the careful planning and diagnosing that goes on how little we achieve. This is not only an issue relating to the least able. Compared to what the most able Hungarian pupils achieved, our best pupils were significantly behind. I do not feel this is just an issue relating to cultural differences.

There is within mathematics education a significant group working on these issues. As Caleb Gattegno stated so well, we need to –

'stop detouring people and forcing on them the wholly inadequate techniques of memorisation and routine employment. Second we need to develop ways of working that keep individuals in contact with their creative powers. In other words, we need

to create the educational methods that give everyone the chance to extend freely the very successful spontaneous learning of early childhood'

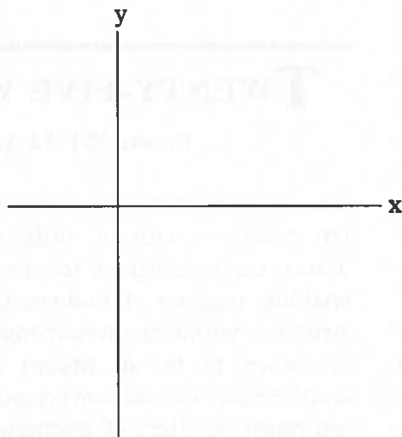
Current educational practice seems to rely heavily on memorising and practice. The National Curriculum tends to encourage a 'building blocks' picture of learning. This is not my experience or my belief about how learning occurs. The role of the teacher for me is to find activities that work on the powers of the individual. Such activities rely on relatively little previous 'knowledge' but require the pupils to make sense of the activity for themselves.

I have enough anecdotes and personal experiences to support my assertions, and I feel frustrated by the pull of these current debates involving differentiation. Whole-class teaching to mixed-ability groups can be very empowering to children, but not when the focus of the teacher is on telling and explaining.

A lesson on functions and graphs

I put on the board the following:

x	y
2	5
6	13



I ask for more numbers that could be placed in the table. After each one I write them as an ordered pair eg (4, 9) and plot the point on the graph. Each time I say nothing to explain, but pause and say their job is to make sense. I have also added a constraint. The numbers must fit on the axes I have drawn. This constraint forces negative numbers and non-integers. I ask how the numbers are found. I then say 'and this is how I write it'

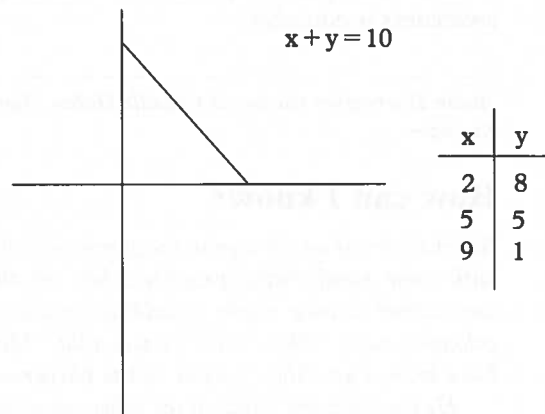
$$y = 2x + 1$$

and then I draw the line connecting all the points. I repeat the exercise with some other functions. In each case there are key moments when the 'easy' points are used up and pupils are forced into an uneasy space. The writing down of the function algebraically also creates a space of discomfort. I feel it is important to give time to reflect on these moments with the group. Creating these moments of discomfort seems important. The energy level rises. The attention higher. I then need to judge when it is appropriate to release this energy so that the pupils can work in their own space –

maybe an opened ended activity or questions from a text. Judging when to release is important.

This was with a mixed ability year 7. I didn't plan with the different abilities of the group in mind. They all seemed to engage in the activity. Work at many levels seemed to be going on: number, algebra, infinity, imagery ... I have all sorts of stories about what I was working on, but paying attention to the individual abilities, whatever that means, was not one of them.

During the lesson I am aware of being in the moment. I am working with what I hear. But it is not as simple as that. I have a tight structure. I have some questions. What is more important is that I am aware of the energy present in the class. I sense the rise and fall of involvement. I notice the boundaries.



When I worked with the above example, many avoided moving beyond the positive integers. I set constraints to force this to be worked on. I had not pre-planned this. What feels important is that I find ways to increase my sensitivity to these moments. I have taught lessons where I have pre-planned or more usually re-used an idea. It rarely goes as well. In such lessons my attention is in a different place. When I plan them I am not in the moment, I am in the future. I am no longer sensitive to the choices present in the moment. I feel that if I am asked to pay attention, in my planning, to the individual, I can never be as effective. I have to be in touch with myself. I have to be in the moment. I am also conscious that many pupils will not have mastered the topic. That does not worry me. I had a series of lessons where I had a strong feeling of involvement. A whole range of things were going on ... making sense of the algebra, differences, adding on ... I offered an activity that was accessible. There were few pre-requisites needed to engage. In terms of the National Curriculum it has the appearance of content aimed at the higher end.

The debate about differentiation is a strange one. I have found that I have little feel for how to engage with it, or maybe it is a reluctance. I am certainly aware of individual differences in class and

also see different pupils making sense of the lesson in different ways. I suppose I have seen little success with the strategy of paying attention to a perceived idea of where the pupil 'is', and then planning the lesson around this. I come back to the Hungarian's observation 'for all the attention you pay to your less able they can do so little'. I do not feel that just paying more attention to the planning of these lessons will make much difference. I was moved by Gattegno's challenge in his address to the 1988 ATM conference "People often say 'I teach them but they don't learn.' Well, if you know that, stop teaching ... stop teaching them in the way that doesn't reach people". I do not feel that the issue is about finding out about the pupil. The role of the teacher is to focus the attention of the pupil. To awaken the pupils' powers of learning. Only awareness is educable.

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How can I know?

She was sitting on her own in the classroom catching up with some handwriting practice while all the others were either writing poems or adding up with brightly coloured cubes. 'She's new.' I was told. 'Her family have broken up. She's trouble in the playground.'

He was on book 5 and all the others were on book 4. 'He's not from this area. I don't know why his parents send him here.'

How should I differentiate between children? Can I choose to offer to one what I do not offer to another? Can I choose to give one a wide vision to explore and another a sequence of small steps to follow?

What do I know of ability that I can judge another? I, who can barely define mathematics and have little idea of my own undeveloped abilities. (What is my ability as a saxophone player? What is my potential?)

Do I have the energy to search and search for ways to help children understand? Do I offer written mathematics to those who can hardly read, or to those who would rather imagine a broad landscape?

How did the person who taught me to wire a plug choose what to tell and what to withhold? Why was I given a rule of thumb and not a chance to explore electricity?

Which would I rather be: Unlikely to be surprised by what my pupils can do? Or constantly surprised?

When I listen to friends and family I miss some things and misunderstand others. When I listen to pupils what do I miss or misinterpret?

There is an obsession running through much current thinking in education about making

simplistic judgements about the complexities of the intellect, or other developing human aspects, and using these inducements to treat people differently.

'... and do not call the tortoise unworthy because she is not something else...' (Walt Whitman, *Son of myself*)

Differentiation-by-task presupposes inducements about understanding and potential and, carefully done, leads to teachers' expectations being fulfilled. How neat!

Differentiation-through-interaction requires me to listen, to know when to speak and when be silent, to believe I can make a difference and take responsibility for that, to be flexible, to be happy about different outcomes ... and surprises. To be un-neat.

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TWENTY-FIVE YEARS AGO

From MT 52, page 51

The absence of theory, even at molecular level, has left teachers without sufficient 'anchor points'. There are insufficient theoretical cross references enabling teachers of mathematics to form a working structure within the newer mathematics. This need is shown to be an urgent one at courses and conferences. Casual conversation soon reveals that too many teachers of mathematics feel inadequate and anxious. They are frightened of change. In some cases this fear exists at pathological strength. As one teacher put it, 'I am bewildered; caught up in a whirlwind of change, surrounded by advice, frankly I don't know what to do'. And sometimes the advice doesn't help. Caldwell, in a book review in MT44, emphasises the point. He writes, 'those of us who are non-mathematicians are constantly reminded that we are intelligent and constantly talked at as if we were not'. The outcome is rejection of well-intended advice and instruction. But the need for remedial action still exists. Teachers ought not to be forced into a situation paralleling a laboratory rat. Like the rat in a Miller shock box, they take up an avoidance position, anxious to go on but fearful to do so.

L R Chapman