Equals

mathematics
and
special educational needs

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MATHEMATICAL ASSOCIATION
supporting mathematics in education

Equals
mathematics and special educational needs

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Editorial

What have the number of commandments, Bo Derek, the Roman numeral X, the number of sides of a decagon and this edition of *Equals* got in the common? The answer of course is the number 10. This is the first part of Volume 10 of our journal. It's not our 10th birthday, because we started with Volume 1 Part 1, but thanks to our number system we have now reached 'double figures'. (But birthdays do figure in this issue: Mark Pepper writes about how he used a birthday cake as an opportunity for his class to learn something about fractions.)

As well as the start of our tenth 'season' I am writing this on the first day of 2004. Looking back at past editions at this time, there have been several interesting things that editors and contributors have done with the digits of the year and interesting palindromic dates that occur during the course of the next twelve months. Is there anything interesting, numerically, you can do with the digits of 2004? e.g. $(2 + 0! + 0!) /4 = 1$. Is it possible to make all the numbers from 1 to 20? Only a rather sad mathematician would ask such a question on New Year's Day!

As usual, this issue features a varied selection of articles, offering more insight into some of the extra difficulties some children with special educational needs experience with mathematics. Dyslexia is one such source of difficulty. One usually associates dyslexia with pupils who are failing in school, not with undergraduate mathematics students. However, John Searl and Sharmila Sivalingam's research explores the nature of the condition and compares the difference in performance of different groups of students. Are there some lessons to be learnt here for teachers in primary and secondary school classrooms?

We have two very different articles about parent/teacher relations. Lucy Handy describes how she has involved parents of pupils in her school by inviting them to share mathematical experiences with their children and to inform them about different approaches now being used in mathematics classrooms. However, it appears that our anonymous contributor's children aren't being taught a great deal differently from children 40 years ago!

Marion May and Sue Clarkson present a very useful contribution to classroom practice. Marion and Sue discuss the difficulty pupils experience in using an electronic calculator as they move from Key Stage 2 to Key Stage 3. The widespread availability of calculators should have been one of the most powerful tools for the teaching of mathematics in the latter half of the 20th Century. They have not had the impact they should have because of calculator skills not being taught to pupils. If every mathematics teacher made it a New Year resolution to teach children basic calculator skills and model their use in the classroom in all areas of mathematics, we are sure standards would dramatically rise. You could start by using some of Marion's and Sue's ideas.

Games are rarely seen in secondary school classrooms. Annette Glatter's article on the work she has done in developing board games to support pupils in practising mathematical skills shows the power of putting a different type of activity into the classroom and she shares one of her ideas with us in this issue's centre spread.

Stewart Fowlie, in his article on geometry, details an innovative approach to helping pupils to develop a sense and feel for shape. Rachel Gibbons' paperboy does not have a 'sense and feel' for number and her experience is one many of us can relate to when sometimes even the simplest calculation is beyond many shop assistants. The other day a young man of about 16 in my local supermarket could not give the correct change from £5 for something costing £1.99! Where have we gone wrong, besides not teaching calculator skills?

We are also delighted this month to have two contributions from school children. Anne Marsh contributes a review of a book she found really useful as she prepared for GCSE and Jamie Mellor and Caroline Riley, two primary school pupils, provide this issue with some unusual Pages from the Past, writing about a 17th century mathematician who overcame great physical difficulties to become a professor of mathematics at Cambridge University.

We have done the first write up of the Equals session at Special Needs London last autumn and hope the comments of the participants will continue to inform the contents of the rest of Volume 10. If you have topics you want covered please let us know. Indeed if you have any comments that will inform others we are always looking to receive articles, which will be of interest to our readers. Please keep sending us your contributions and make the 'tens' volumes of this journal as good or better than volume numbers 1 to 9!

Dyslexia and mathematics at university

John Searle and **Sharmila Sivalingam** present some research they have done on tracking the progress of a small group of dyslexic university mathematics students

Dyslexia is traditionally associated with difficulties relating to the acquisition of language and literacy skills. Limiting the features of dyslexia in this way is tantamount to ignoring the full story. If one is talking about dyslexia one is talking about a constellation of difficulties (Joffe, 1983). These difficulties sometimes transfer to the learning of mathematics. There is little published work showing how dyslexia affects the performance of individuals in mathematics. Independent studies have, however, shown that not all individuals with dyslexia have problems with mathematics, indeed some dyslexics are gifted in mathematics. It is possible that all dyslexics have difficulties of some kind with mathematics. However, there is considerable variation in the extent and nature of these difficulties and in the extent to which they are overcome.

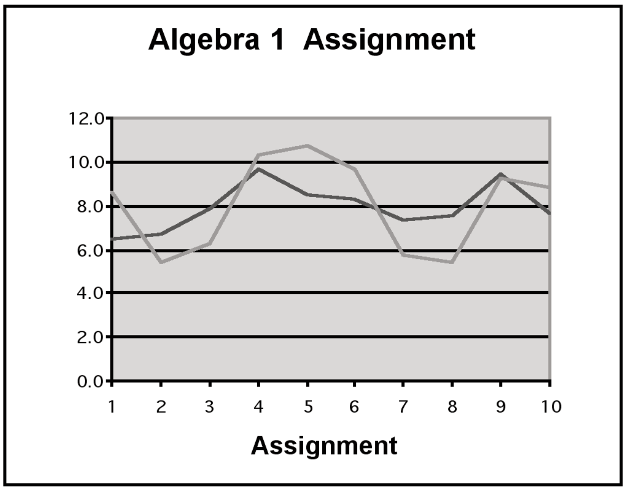
Such literature as exists on dyslexia and mathematics at higher levels at school or college focuses either on describing possible difficulties similar to those experienced at lower levels of schooling or advising dyslexics to choose away from certain subjects or courses in light of their difficulties! One reason for this may be that it is commonly accepted and expected that dyslexics with severe difficulties will not enter higher education. It is those dyslexics whose difficulties are not as severe or who have developed sufficient coping skills that do.

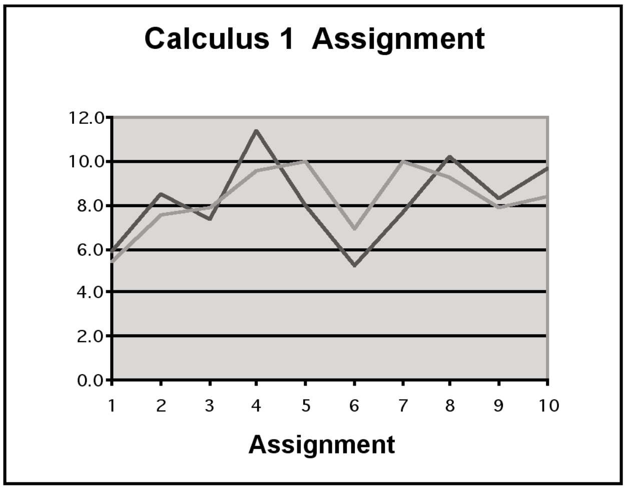
In a short study we monitored the progress of the nine dyslexic students within a group of four hundred students taking mathematics as a service subject in the first year at the University of Edinburgh. Their progress was compared with that of a random sample of non-dyslexic students with similar academic backgrounds and qualifications.

While working with dyslexic students during their tutorials, it was observed that they appeared to have greater difficulties with certain topics in mathematics as compared to their non-dyslexic peers. This was despite their more regular submission of assignments and attendance in lectures and tutorials. Many in this group appeared to be frustrated at not being able to cope well with undergraduate mathematics especially since they had little or no problem with mathematics in school. Because dyslexics experienced little or no problems with mathematics while in school, it does not necessarily suggest that they have no difficulties with mathematics. Sometimes the difficulties they experience are of such a small extent that they get masked in school mathematics, showing themselves only at higher levels when more refined skills are required.

A survey of the students suggested that the majority of the dyslexic students were experiencing more difficulty than their non-dyslexic peers despite their success in mathematics at school. Their success in terms of assignments, however, showed that they were coping well in the first semester. These data do not tell us how much more effort was required to achieve those results.

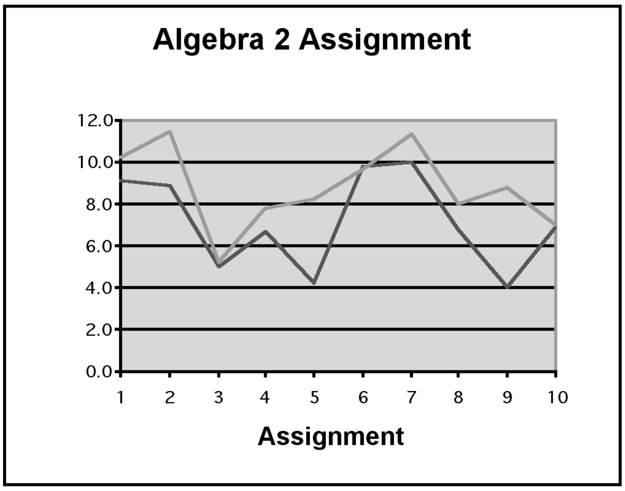
The diagrams show the results for the first and second semesters in algebra and calculus and compare them with a randomly selected group of non-dyslexic students. These show that the dyslexic students performed as well as their non-dyslexic peers in the first semester but in the second semester they consistently performed at a lower level.

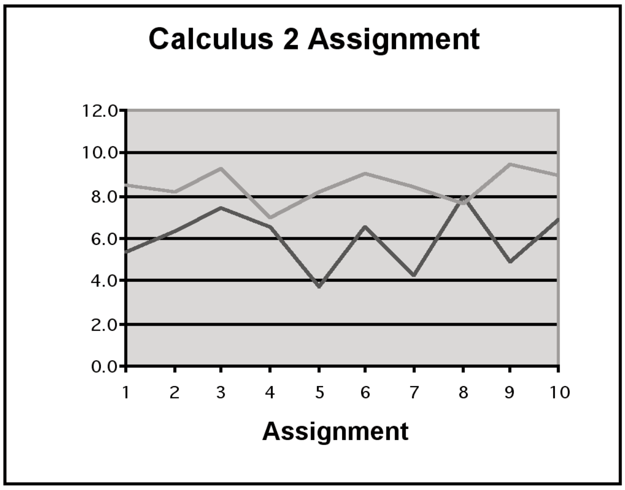




Dyslexic

Non-Dyslexic



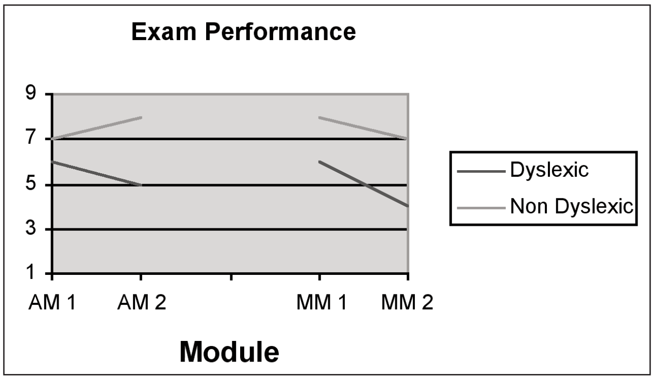


Dyslexic

Non-Dyslexic

Much of the material taught in the first semester was consolidating the mathematics covered at school. The almost consistent existence of difference in performance in the second semester suggests that dyslexic students had greater problems with assimilating new material. Time pressure may be an important issue here. Part of the algebra module in the second semester was covered by self-learning materials in the form of printed notes as an Easter vacation task. This corresponds to assignments 6 and 7 of that course.

The students had effectively 5 weeks in which to master the material instead of the usual 2 weeks. Here the dyslexic students perform better. Performance in the corresponding calculus assignments, however, shows that we must be cautious in drawing conclusions. The dyslexic students performed significantly less well in the end of semester examinations as the diagram below demonstrates. That diagram also illustrates the relatively greater decline in success rates as the students move from semester 1 to semester 2.



Number of examination passes for both groups (nine students in each group)

Mathematics specific difficulties experienced by dyslexic students

Not all the dyslexic students in the group experienced difficulties. Two had no problems, a third student overcame his difficulties and was ranked in the top ten percent in the examination. The study revealed that the nature of the difficulties was not special or different to those experienced by their non-dyslexic peers. The dyslexic students, however, had greater difficulty and needed more assistance to cope with them. Dyslexia often added an extra dimension to the difficulties. We give below some of the areas that caused difficulties.

Working with Patterns

Difficulty working with patterns often is a feature of dyslexia so that a topic like the binomial theorem gives considerable difficulty.

$$(1+x)^r = 1 + \binom{r}{1}x + \binom{r}{2}x^2 + \ldots\ldots\ldots\ldots$$

One undergraduate had a profound handicap when it came to pattern recognition. To find the six terms of the series $(1+x)^5$ was a problem. Because he was unable to see the pattern of the binomial coefficients from Pascal's triangle, he would first write out the series,

$$(1+x)^5 \quad = \quad 1 + \binom{5}{1}x + \binom{5}{2}x^2 + \binom{5}{3}x^3 + \binom{5}{4}x^4 + \binom{5}{5}x^5$$

Then he would then evaluate each term of the required expansion individually doing a one-to-one match from the general to the specific term.

$$(1+x)^5 \quad = \quad 1 + 5x + 10x^2 + 10x^3 + 5x^4 + x^5$$

When the question required a greater number of terms or involved a more complicated series, he would draw lines matching each general term to its specific term in order to avoid getting 'lost' in the expansion.

It was also very difficult for him to work out a specific term of an expansion without first working out all the terms before it. For instance, if asked to write down the 5th term in the expansion of $(1+x)^5$, he would have to write out all the terms up until the 4th before being able to write down the 5th term. This was common with other dyslexic students. Factorization caused similar difficulties for many dyslexics.

Problems with Symbols and Notations

Despite experiencing some difficulty remembering the meanings of the various mathematical symbols and notations, many dyslexics learnt to cope with the limited number of different symbols and notations in school. Arriving at tertiary level they found that the language of mathematics contained many more symbols and notations. Often a symbol is used to represent more than one meaning and different symbols and notations are used to represent the same meaning. For instance the derivative of $u(x)$, can be written as u' or $\frac{du}{dx}$ or u_x. In school mathematics, complex numbers are represented with the symbol $\boldsymbol{i}$, but at tertiary level, engineering students find that complex numbers are now represented with the symbol $\boldsymbol{j}$. Indeed each specialism has its own symbology and this is often the source of much confusion and may present a real barrier.

Sequencing

Difficulty with remembering and following a sequence of steps or actions is another feature of dyslexia that makes learning mathematics at tertiary level difficult for dyslexics. This is illustrated well with the topic Differential Equations. Linear differential equations, at this stage, are solved by applying a fixed procedure. Not being able to see the solution as a set sequence of steps, they tried to solve the problem by 'aiming' at the given answer. In contrast the non-dyslexic group of students seemed to appreciate the topic of differential equations because of the fixed procedure that was employed in solving them, displaying no difficulty remembering the steps involved.

An associated difficulty relates to justifying results. Many dyslexics have the ability to 'see' solutions but need a great deal of persuasion to write down a method. They can often give the correct answer to a complicated mathematical problem but when asked, are unable to write down or explain the method they used in a logical fashion.

Remembering Formulae

Students with dyslexia did not like and tried hard to avoid learning formulae. This may have arisen from a sense of insecurity about 'remembered' facts but when coupled with the difficulties they experienced using formulae sheets represented an additional difficulty for them.

Directional difficulties

Though many of the dyslexics had overcome or found ways around their left-right confusion, many still experienced directional difficulties in relation to solving mathematical problems. Working with matrices is often a common source of directional confusion.

The multiplication of matrices requires one to sum the multiples of terms in the rows of the first matrix to corresponding terms in the corresponding columns of the second matrix. (That sentence reveals the source of the problems!) This movement from left to right then top to down is very confusing to the dyslexic. Dyslexics also get confused when describing a matrix, being unsure whether to name the columns or the rows first, so they often confuse a 5 x 2 matrix with a 2 x 5 matrix.

Social changes

A major reason why many dyslexics who had little difficulty with school mathematics find undergraduate mathematics difficult is the big change in teaching and learning support that they experience when coming to university. All of the nine dyslexic students said that they received greater support while in school. In primary and even secondary school, they learned in smaller classes and received more teacher contact and greater individual attention. Being taught in small classes meant that the teacher could afford to attend to individual concerns. Many dyslexics also received support in the form of a teaching assistant who helped with note taking and remedial work or a learning support teacher. The switch from such a supportive environment to that of a mass lecture often puts the dyslexic in a stressful position as s/he now has to learn to listen, read and write at the same time. Of course this is a skill that many employers look for so that its acquisition is important. This social change often has a great impact on learning of many first year students.

Summary

The possibility of a dyslexic pupil experiencing serious difficulties with tertiary mathematics despite having excelled in school mathematics is real. Being aware of this and also of the possible nature of these difficulties is an important first step in helping them overcome them.

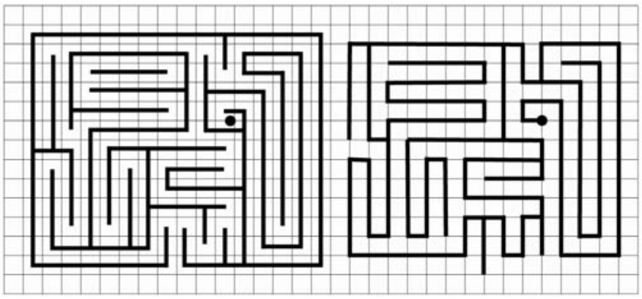
The Edinburgh Centre for Mathematical Education,
The University of Edinburgh

Growing geometry from routes

Stewart Fowlie takes us along a progressive route in geometric drawing from the simplest, suited to early primary classes, to some developments at secondary level.

Understanding even a simple geometric diagram is something which has to be learnt. Copying a scalene triangle drawn on the board on to a piece of paper is an almost impossibly difficult task for some youngsters. This may be because they see the triangle as a whole, just as they see a dog as a whole, not made up of simple elements.

The child has to learn to scan the triangle, letting his eye move round it, so he can see the elements, one by one. Then he can move his hand in such a way that his pencil scans the triangle. What follows is a way to encourage the child to scan in this way and it is intended to be spread over 4 or 5 years, as maturity develops. It all grew from working with a severely dyspraxic 13 year old who told me that a number line made much more sense to him if it went up and down rather than as he put it "being flat".



"hedges" *"routes"*

Here side by side are two representations of the same maze, drawn on $\frac{1}{2}$cm squared paper. On the left the "hedges" are drawn, On the right, lines marking the centres of the paths are drawn. Some children seem to find the left hand form easier to understand and find their way round, though I remember at the age of seven or eight creating mazes like the right-hand version; it was a year or two before I felt I could try to do the other version. (To understand these diagrams thoroughly the reader might draw in the "hedges" in green on the right hand diagram.) My friends and I were just doodling after we'd finished a piece of written work, setting each other puzzles like ones we'd seen in our comics: this was fun after doing boring "sums"!

Maze and labyrinth as context for coding movement:
Trying to find the way to the centre is an occupation most children enjoy. In the example above, there are two separate solutions.

- Can they find both?
- Which is the shorter?
- Can they find a way of writing down the route?

Think of each short line as being one step, and count up how many steps it takes to reach a corner. For each change of direction draw an arrow-head to show which way you go next (relative to the paper, not to which way you're facing). A solution might begin:
^ 3 < 1 v 2 < 6 ^ 5 and so on. (This is to be interpreted: up 3 squares, backwards 1square, down 2 squares, backwards 6, up 5.)

Many questions can be invented based on the same maze.

- If you start at any particular point, how do you get to another?
- If you start at any particular point, where do you finish if you carry out a given set of instructions?
- Can you sketch a given path on a separate piece of paper?

Even making a copy of either version on a clean (squared) piece of paper is worth while, as is making up a maze for your friends to try. Some may feel more confident at first making a labyrinth - like a maze but with only one long tortuous path: start at the centre and make up the path for getting out.

With experience of that behind them it should be easy for children to write down simple instructions and use them to draw a square or a rectangle. Again using the words backwards for < and forwards for >, with up for ^ and down for v, write the instructions
v 6 > 4 ^ 6 < 4. Say as you write, "arrow 6 arrow4 arrow 6 arrow 4", so that the children are forced to copy what is written rather than taking dictation from your speech. Ask them to mark where they are going to start, and put a dot where each line in turn will finish before drawing it. This will enable them to correct any mistake before the lines are drawn. Also get them to put an arrow-head on each line to show which way they went. (—>—).

Oblique line as a composite move

Understanding oblique lines is a quantum jump! They may be introduced like this. Invite the pupil to draw >5 ^ 3, and then add the line to get back to the start. Then say what you wanted was the line from his starting point to his finishing point: starting again, mark the starting point, and then the point for the end of >5, and then the point for the end of ^ 3. Join the first point to the last, put on the arrow- head, and there you are!

Say that when you want them to do this, and not draw the separate lines, you will put the two instructions in a bracket, e.g. (>3 ^4), and then add a similar bracket for the next line. Thus you might give the instructions A(>3 ^ 4)B(> 6 v 4)C(< 6 v 4)D(<3 ^ 4), and they should draw the kite ABCD. Should you want them to draw >3, it may be helpful to start calling it (>3 0). ^ 4 would be written (0 ^ 4). Make sure everyone realises (^ 4 < 3) is the same line as (< 3 ^ 4), but settle to always giving the across instruction first.

All this work can be closely associated with LOGO and done on computer maybe more effectively because the pupils can "build in" the words/procedures to create the new shapes/journeys.

In the end the arrow-heads will become + or - . Be careful not to put any commas in the brackets, as that is the way coordinates of a point will be given in future. It is also important that at least some of the diagrams drawn are cut out, to emphasise that, for example, a rectangle is not so to speak a fence round a field, but the field itself. The edge of a piece of paper or a fold is a better representation of a line than a drawn line, which is literally a drawing of a line. If you look at a drawing of a face by a child it will consist of lots of "lines". A pencil sketch of a face by an artist will probably contain none, consisting entirely of shadings.

Using coordinate points for geometric shapes:

Mathematically knowledgeable teachers may realise that these brackets really represent vectors, but that need concern nobody! What matters is that attention is being focussed on relative lengths, and how much you have to turn at each corner. Making up their own instructions for isosceles, right-angled or scalene triangles, and for squares, rectangles, diamonds, kites, parallelograms, trapezia, and guessing what a set of instructions would give without actually drawing it all focus on what mathematics teachers in the future will want your pupils to see. It is probable that revision of all this might include abandoning the arrows, and introducing axes of coordinates and coordinates of a point. If O is the origin, and OA is the line O*(a b)*A, we write A is the point A(*a, b*). A figure could sometimes be defined by specifying its vertices, sometimes by specifying its sides.

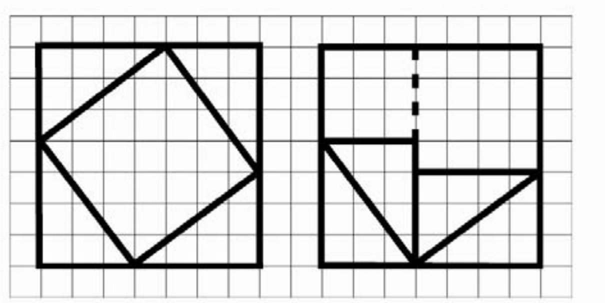
There are two questions which can be asked for each of the diagrams drawn:

- what is the distance all the way round it (*its perimeter*)?
- what is its area?

Surprisingly the area is easier to work out than the perimeter. All one has to do is count the number of unit squares inside it. This is best done by putting it in a box, as in the first diagram below, and using the idea that the area of each right-angled triangles so formed is just half the area of a rectangle.

Pythagoras with its title

Of particular interest is the area if the diagram is a square. Given any line it is easy to draw a square having that line as one of its sides. If the line is (4 3), the square round the outside has area 49 units^2. Each of the triangles has area 6 units^2, so the area of the square in the middle is (49 - 6 x 4) units^2 = 25 units^2. Because 5 x 5 = 25, each side of the inner square must be 5 units long. So the line (4 3) is 5 units long.



It will be useful to do quite a lot of examples of this type, fixing the concept of the meaning of square root, and how it can be found from a calculator. In the end the children need to understand why the 25 above comes from working out $4^2 + 3^2$. The diagrams show this, but the parts of the diagram should be cut out of card, so that the triangles can actually be moved. Each child should have three large squares of card. The first square will just be used as a base. The four identical triangles should be cut off the second, leaving a square, and the two smaller squares cut off the third. That $c^2 = a^2 + b^2$ can be demonstrated, and thus the length of (a b) = $\sqrt{(a^2 + b^2)}$.

Edinburgh

The Innumerate Paper-Boy – a cautionary tale

Do you agree with **Rachel Gibbons** that a feeling for number is what will last a lifetime while mere rule-learning can fade fast?

I only have papers delivered two days a week – the *TES* on Friday and the *Guardian* on Saturday and this causes my newsagent almost insuperable problems. Almost every week I get a different selection of papers or, possibly as often, no papers at all. Last Friday I rang for the *TES* yet again and was told that “the boy” would bring it round. It did not arrive. A couple of hours later I called in at the shop, picked a *TES* from the stand outside the shop and went in to complain. “What happened this time?” asked the newsagent. If he didn’t know how was I to guess?

As I left the shop “the boy” followed and told me that he had been down Britannia Road to the bottom and the first house had the number 2. He had looked at the next one and found no number but the next again was labelled 6, so he had delivered my *TES* to the numberless house in between no.2 and no. 6. I pondered over his number knowledge. Where had he gained it? Some of his phrasing and pronunciation suggested that English was his second language. Had he been in school in this country with his learning of mathematics hampered by a literacy problem? Or had some other country supplied an education with such glaring gaps? Somewhere he had learnt to count, that was clear, probably someone had also taught him addition and subtraction and maybe a little multiplication, even his tables perhaps. Perhaps he had passed tests in these processes. But where was the understanding of odd and even? Did he think it strange that the first house (on the side he looked) was numbered 2? Did he know that the first positive integer is one? And, yes, 3 certainly comes between 2 and 6, but where did he think 4 and 5 had disappeared? … I asked myself many such questions but received no answers. “The boy” just did not have a feeling for number.

How many of your pupils would make good paperboys – or papergirls come to that?

Fulham.

Inside us

A cell … is packed with solid structures, mazes of intricate folded membranes. There are about 100 million million cells in a human body, and the total area of membranous structure inside one of us works out at more than 200 acres. That’s a respectable farm.

Richard Dawkins, Unweaving the Rainbow: science, delusion and the appetite for wonder, London: Allen Lane *The Penguin Press*, 1998

Byte size?

1 kilobyte is nominally $1x10^3$ bytes but more precisely 2^{10} bytes

1x103 = 1,000   210 = 1024

1 megabyte is nominally 1x106 bytes but more precisely 2^{20} bytes

1x106 = 1,000,000   220 = 1,048,576

1 gigabyte is nominally $1x10^9$ bytes but more precisely 2^{30}

1x109 = 1,000.000,000   230 = 1,073,741,824

Chambers *Dictionary of Scientific Terms*

Mathematics has changed so much since I was at school...

Lucy Handy describes a recent sucessful evening event for parents. The emphasis was on actively involving parents in a variety of mathematical activities.

We decided to hold a Numeracy Evening to inform and involve parents in the way mathematics is taught today. So many of our parents want to support their children at home, but find the strategies used in schools different from the way they were taught. We also wanted to demonstrate the practical, investigative and mental aspects of the subject, so parents could see the interactive nature of mathematics lessons.

Welcoming the parents

As the 150 parents entered the hall, a display of children's work highlighted key objectives and strategies used across the school. A selection of visual and practical resources was also available for parents to look at.

After the headteacher had welcomed everyone, I presented parents with a short introduction, outlining the aim of the evening. The talk began with two quotes parents easily related to: "mathematics has changed so much since I was at school" and "my teacher doesn't do it like that".

The presentation showed parents how mathematics lessons no longer consist of the teacher handing out textbooks, giving you a page number and telling you to get on with it. I highlighted how today's mathematics teaching and learning in schools has a greater focus on two main strands: mental calculation strategies and putting mathematics in context.

I explained how, in Key Stage 1, children are encouraged to develop their knowledge and understanding of mathematics through lots of practical activities, exploration and discussion. Then during Key Stage 2, children learn to use the number system more confidently, tackling problems with mental methods before using any other approach. As pupils progress to working with larger numbers they learn more sophisticated mental methods which allow them to tackle complex problems easily.

Parents were given the calculation 37 + 45 and shown strategies such as partitioning, using a number line and other informal written methods. This was to highlight how, by teaching children mental strategies first, their children can manipulate numbers much more quickly than if they had to write everything down. I emphasised how vital discussing strategies is today, so that children know how to approach questions like this.

The evening's introduction concluded with some ways parents can support children with mathematics by integrating it into as many activities at home as possible. Here are some of the examples I gave:

- When **shopping**, get children to calculate money problems by adding items together or calculating change. Pose problems like: which is better value for money - 1 litre of coke for 89p or 2 litres for £1.75?
- **In the car**, ask questions such as: 'We are travelling at 30mph. If I travel for $1\frac{1}{2}$ hours, how far will I go? I need to get to Bristol in 2 hours. It is 120 miles away. How fast do I need to go? How many metres in $2\frac{1}{2}$ km?
- Whilst watching **football** , you ask: which two players' shirts have numbers adding to 10? How many minutes of the game are left?
- If you are **cooking** and baking, get children to measure ingredients. Pose problems like: To make a cake for 6 people I need 2 eggs and 500g of flour. What if I want to make a cake for 3 people?
- By playing scrabble, darts, cards and similar games, you are reinforcing key number skills.
- Your child can develop their **estimating** skills in any context e.g.: the weight of tins when putting away the shopping, the length of objects around the home, the time it takes to lay the table.
- And **discussing** mathematical calculations is just as important as doing them, so ask your child: how did you work that out? What facts/strategies did you use to help you?

The nursery department then demonstrated two games in which children have to 'Guess the Shape' by using key vocabulary to ask questions. Audience participation was required, and the nursery children really enjoyed trying to catch them out!

Classroom activities

For the next 40 minutes parents were invited to visit the classrooms where we had the following activities:

Miss Fry Mrs Spicer	Milne Room Nursery and Year 1	**Numeracy games**. A demonstration of how games can be used to support learning. Games include: number recognition, addition and subtraction, shape, money and ordering numbers.	Demonstration
Miss Wentzel Miss Webster	Ahlberg Room Year 1 and 2	**Mental starters.** A demonstration of the mental/oral starter which occurs at the beginning of mathematics lessons. Number fans and whiteboards will be used to develop the children's understanding of number facts.	3 x 10 minute demonstrations.
Miss Galvayne	Dahl Room Year 3 and 4	**Mathematics Investigations.** Four investigation activities will show how children might approach a range of open-ended tasks.	Parental participation.
Miss Rogers	ICT suite Year 3 and 4	**Interactive mathematics software.** children will demonstrate a variety of Mathematics games available in our ICT suite.	Demonstration and parental participation.
Mrs Field	Lewis Room Year 3 and 4	**Shape and space: the language of mathematics.** Using tangrams, children will instruct each other to make shape pictures. This encourages children to use language associated with shape, orientation and position.	Demonstration first, then parental participation.
Miss Handy	Stevenson Room Year 5 and 6	**Capacity.** An ICT based introduction to reading scales which develops children's understanding, so they can measure capacity through practical activities.	Demonstration first, then parental participation.
Mr Wilkinson	Swindell Room Year 5 and 6	**Mathematics across the curriculum.** Children will link history to mathematics by demonstrating how to calculate problems 'Egyptian' style.	Demonstration and parental participation.
Mrs Barnett	Morpurgo Room Year 5 and 6	**Using calculations effectively.** Children will use calculators in a range of problem solving activities, where they will have to make decisions.	Demonstration and parental participation.
Mrs Gregory	Waddell Room Year 5 and 6	**Key Stage 2 Mathematics puzzles.** A variety of games and puzzles will be used by the children (and parents!) This activity aims to develop their understanding in a range of mathematics topics.	Parental participation.

Concluding the evening

On returning to the hall, parents were given a SATs style mental mathematics quiz using some of the questions from last year's test. Feedback was very encouraging, with many parents commenting on how much they had enjoyed participating in the activities. Overall, the evening was a success, and had certainly helped parents to understand how mathematics has changed since they were at school.

Holyport CE Primary School
Royal Borough of Windsor and Maidenhead

We’re not bored playing board games!

Annette Glatter, a mathematics teacher in Slough, has spent the last few years developing board games to help pupils practise mathematical skills. In her article she describes her labour of love. Our centre spread features one of the many board games she has produced.

When I was in Year 10 at school, I was what you might call ‘flunking’ maths. I was uninspired by the ‘chalk and talk’ lessons and having to work through pages and pages of exercises. Entering Year 11 however, I was fortunate enough to have a change of teacher, a teacher who oozed enthusiasm and made maths seem fun rather than monotonous. After a GCSE prediction of grade D in Year 10, I went onto achieve an A* and after studying Maths at A level, was the only student in the Year group to go on and study it at university.

And so my vocation was chosen - if one teacher could inspire me so much, I wanted to do that for others. I wanted to train to be a teacher and I wanted to make maths fun for others.

I wanted my students to talk maths, play maths and most importantly enjoy maths. The very first game that I developed which did this involved a game board with equations. This involved the children playing against each other, in pairs or threes, to solve the equations, and if answered correctly, they would get to move the number of places of the solution.

It wasn’t long before I was creating harder equation cards, cards on different topics and (the key motivating factor) new boards. Five years of development, trialling new ideas and discarding old ones, constantly building and improving the cards and boards – I had created a compendium of six games – each with three levels of cards. Other teachers would ask to borrow them, and then wanted their own and it was suggested that they should be made available to other teachers too. But how? A publisher? After five years, could I hand them over? How could a publisher be as passionate as me about them? How could they understand how or why they worked so well? How could I do it myself? I was a teacher, with no business experience (except a 2-day course I went on in my sixth form years!). It would be safer to hand them over, I thought. So what did I decide? Well, the riskier, more stressful, but by far the most satisfying of the two – I took the plunge!

I am still a teacher first and foremost and spend my spare time showing teachers nationwide the motivation of ‘Mathletts’ as I’ve called them. When I take them into schools and see the wonder on teachers faces at the interaction and enjoyment they can see the children experiencing, and the children themselves ‘doing maths’ without even realising it – it makes it all worth it.

Due to the lack of ‘formal’ writing involved, the games access children who are otherwise quite shy and lack confidence and those children who suffer literacy difficulties. It is amazing to see these and quite disaffected children engaged so enthusiastically, and as one child said once ‘It is motivation to get the answers right. You want to do it instead of being told you have to’.

I’ve differentiated the levels of cards, so that a level can be used independently or in combination with others, and that the game boards can be interchanged too. The cards access Key Stage 2, 3 and 4. The games are most effective when used to build on and practise ideas and skills that have been taught in an earlier part of the lesson or module and work very well for revision purposes too.

It has been an extremely steep learning curve for me – with a considerable amount of time, effort and investment gone into it, but when I opened up my e mails this morning from 3 different mathematics consultants telling me how much their schools were enjoying the games, I realised my initial teaching objective really is being met, in more ways than one!

SPIRALS

Each pair should have:
1) A game board
2) One counter for each player
3) The appropriate level(s) of question cards

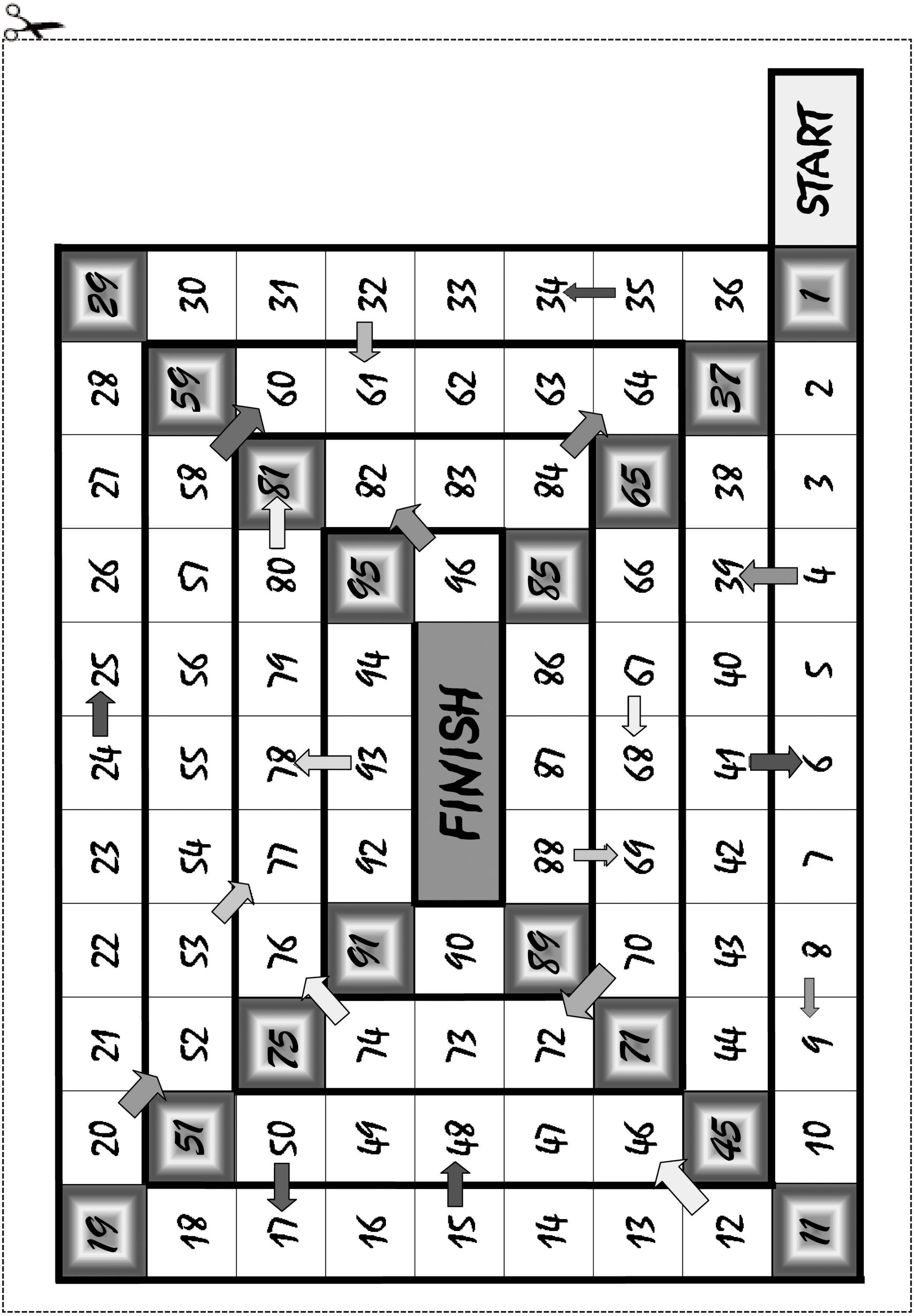
Objective: To be the first player to reach the 'FINISH'.

To set up: Place one counter for each player on 'START'.
Shuffle the question cards and place them face down.

Rules

- Players take it in turns to work out the answers to the question cards and move the appropriate number of spaces on the board.
- If an opponent challenges an answer correctly, the player challenged forfeits a turn.
- Players should move around the spiral in number order.
- If a player lands on a square that has an arrow, they must move to the square that the arrow points to.
- If a player lands on a multi-coloured square, they can have another turn.
- The first player to reach the 'FINISH' is the winner.
- If play is stopped before any player has reached 'FINISH', the player who is nearest wins.

Note: If a player works out a negative solution from a question card, the player must move backwards the appropriate number of spaces, unless on the 'START' square.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FINISH

2 - 5	- 3 + 10	- 2 + 12	- 4 + 6	6 - 10
- 5 + 16	- 3 + 5	- 7 + 13	5 - 7	- 1 + 10
- 6 + 14	- 2 + 14	- 4 + 2	- 3 + 4	- 3 + 8
- 8 + 16	- 4 + 9	- 5 + 9	- 2 + 8	- 4 + 12
- 4 + 6	- 9 + 12	- 3 + 6	- 4 + 11	- 3 + 9
- 1 + 7	- 1 + 10	- 2 + 6	- 7 + 11	- 5 + 9
- 4 + 13	- 10 + 20	- 10 + 15	- 7 + 8	- 1 + 1
- 8 + 9	2 + 10	- 5 + 3	- 6 + 10	- 2 + 12
- 3 + 2	- 2 + 8	- 8 + 5	- 9 + 10	3 - 4
- 3 + 4	- 1 + 8	- 2 + 7	- 2 + 9	- 4 + 15

Pages from the Past

1. The Spirit of Saunderson

Dear Equals

Springvale Primary School has chosen to focus upon the achievements of Nicholas Saunderson, a remarkable blind mathematician born in Thurlstone near Penistone in the 17th century. This amazing man has remained largely uncelebrated in the local community despite the fact that he ultimately overcame many difficulties to become the Lucasian Professor of Mathematics at Cambridge University.

We are using the success against the odds of Nicholas Saunderson and the personality traits which helped him, to inspire our children and the wider community through a series of creative activities. We hope to have children participating in

Computer Animation
Puppetry
Documentary making
Creation of a website
Development of a community trail
Storytelling
Production of literature
Production of promotional materials
Development of dance, singing and drama skills
Participation in a community musical
Technological solutions
Videoing skills

In addition we are seeking to involve members of our community in school based activities. Amongst other things, we will be inviting successful members of the community and beyond to participate in school activities and discuss with the children the reasons behind their success. We want to capture the imagination of our pupils in order to raise their aspirations and awareness of opportunities.

Andy Platt

On the next page is the life story of Nicholas Saunderson written by two children from Springvale Primary School.

Jamie and Caroline's story

2. The Life of Nicholas Saunderson

Nicholas Saunderson, the son of Ann and John Saunderson, was born in the year 1682. On the 20th of January that same year he was baptised. Nicholas lived on a street in Thurlstone, near Penistone, South Yorkshire, called Towngate. Unfortunately, at the age of one he caught a deadly disease, called smallpox. Even though he survived, he was blinded. At a young age his father, who was a tax collector, taught him maths.

Experiencing the effect of blindness

Nicolas went to Penistone Free Grammar School, in the centre of Penistone. Life at school was difficult for Nicholas for there were no Braille books. The teacher of the school, Mr. Staniforth, taught Nicholas and his other students French, Latin and Greek. He also taught Nicholas mathematics.

Nicholas was blessed with a fantastic memory. Forty years after leaving Thurlstone, he came back to visit his home and family. He remembered the gate he used to go through. The hinges had been changed the opposite way. Nicholas remembered this from after 40 years.

As Nicholas grew older, his sums became more complicated. To deal with these problems he created a pegboard, which helped him a lot with his calculations.

The story goes that Nicholas went to Penistone Churchyard, to feel the gravestones. This is the way he taught himself to read. People nowadays use a similar method called Braille.

In the year 1700, two men called Dr. Nettleton and Mr. Richard West tutored Nicholas in algebra and geometry. Nicholas amazed his tutors with his brilliant mathematical knowledge and his ability to make difficult calculations.

Two years later, aged twenty, he was sent to Jollies Academy in Attercliffe, Sheffield. At Jollies he was taught logic. He learnt poetry and how to play the flute.

In the year 1707 (aged 25) he went to Christ's College, Cambridge himself! Not as a student and not at the University but as a private tutor for his friend, Joshua Dunn! Other students took him on as their tutor. At the college it became known that Nicholas could pass on his ideas easily. He was a brilliant teacher. Horace Walpole, the Prime Minister's son was one of Nicholas' students. He found mathematics quite difficult. Horace paid Nicholas quite a lot. After a while he didn't get anywhere. Nicholas said to Horace, "Young man I would be cheating you of your money, you will never learn what I am teaching you."

In the college there is one very important person, called the Lucasian Professor of Mathematics. A man called Henry Lucas, the long-term secretary to the Chancellor of Cambridge University, had donated £100 every year to the person holding the job.

William Whiston, who was the Lucasian Professor at the time, was so impressed with Nicholas that he encouraged him to teach mathematics at the University. Nicholas became part of the Newtonian school of mathematics. The school got its name from Isaac Newton. (Another fantastic genius) This meant that Nicholas could follow and explain what Newton said. Nicholas lectured with William Whiston and Roger Cotes. Roger Cotes told Nicholas he was incredibly bright for his age.

After a while the University sacked William Whiston because he had the wrong religion and did not consider other people's opinions.

Cambridge University had to get a new Lucasian Professor. To do this they had to have a vote. Many people wanted to vote for Nicholas, but he didn't have a degree. To get a degree, students had to study and take exams. The Chancellor of Cambridge decided that Nicholas would not have to take any exams, for he knew most of the things already.

The Chancellor asked Queen Anne, to grant him with a 'Master of the Arts' degree. Now, even though Nicholas was getting many votes, so was his opponent, Christopher Hussey. Isaac Newton and, surprisingly, Roger Cotes were voting for Hussey.

Amazingly, Nicholas won the vote, by only 2.

On the 20th January (aged 30) Nicholas gave his first lecture as the Professor. At first it was quite difficult but it got easier as he went along.

On the 26th of April 1726 Nicholas was honoured when King George II awarded him with a Doctor of Law degree. 11 years later Nicholas married Abigail Dickons, daughter of William Dickons, rector of Boxworth, a village near Cambridge. It is said that as soon as he met Abigail, they were in love.

Nicholas had lots of hobbies including horse riding, hunting and music. Together, Nicholas and Abigail had two children, named Anne and John. (If you have noticed they are the same names as Nicholas' parents)
In 1733 Nicholas was struck by a fever, which was life-threatening. He was urged by his family, friends and people at the University to write a book about his notes on Algebra. The last six years of his life were taken up writing his book. Unfortunately, the book, called The Elements of Algebra was not published until after his death in 1740.

At the end of his life, Nicholas suffered from scurvy, which killed him. He died on 19th April 1739 aged 57 and he was buried in Boxworth Church. On the floor, nearby his grave, a stone plaque tells about his achievements.

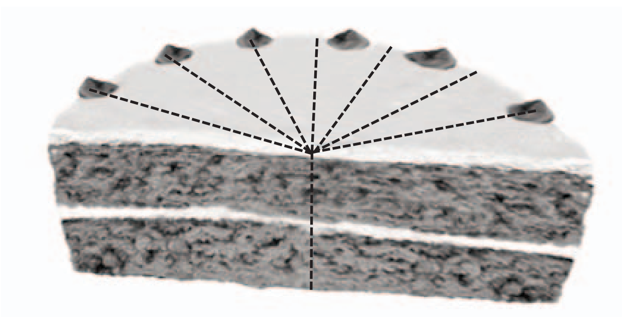
Social fractions

Special needs children, with a responsive teacher, **Mark Pepper**, find repeat actions of halving – and eating - a cake congenial for fractions.

It was Jenny's[1] birthday and she brought in the remainder of her round cake, about a half. Her maths lesson was first period in the afternoon and she was keen to share the cake with the other students. This presented a dilemma for me as eating cake did not appear to be a very mathematical activity! One of the other girls suggested that we should use fractions to divide the cake equally. This provided the perfect opportunity to combine a social occasion with a mathematical one.
There were 7 hungry students eagerly waiting to eat the cake. The group agreed that the cake had to be divided into 7 equal portions. I asked for suggestions of how to do this but none were initially forthcoming.

I then suggested to the group that approximately half of the cake was left and they accepted this. I asked them how many degrees were in a circle. After some hesitation one of the boys said "360". I confirmed that this was correct and then asked how many degrees there were in half a circle. One of the girls said 180. Correct again. With some prompting the students concluded that 180÷7 would provide us with the number of degrees of the angle required for each slice. The plan was to measure this with a protractor but we then encountered practical difficulties. The protractors were fairly old and grubby and it would have been unhygienic to place one of them on the cake, so this strategy was abandoned and I asked for other ideas.

At points around the perimeter of the cake there were 6 small blue knobs of icing sugar. One of the boys suggested that we simply cut through each of these knobs to the centre of the cake. However, one of the girls showed commendable estimation skills, pointing out that the knobs were not equidistant and so the cake would not be cut into equal portions. So this strategy was also rejected by the group.



At this point I suggested that we should use practical action fractions. It was clear that the students would need a considerable amount of guidance to work it all out. I asked them how many pieces we would get if we cut the cake in half. The response of 2 was immediate. I then asked how many pieces we would have if I cut each of the halves in 2. After some hesitation the response was 4. I asked how many pieces we would have if I cut each quarter into 2. After considerable thought, it was eventually agreed that we would then have 8 pieces.

"So that is how we will do it," I said triumphantly. But there was another protest.
"But there are only 7 of us and that will give us 8 pieces" said one of the boys. "Then I will eat the other piece!" I said. There was universal agreement so all that now remained was to cut the cake in accordance with our agreed strategy.

The combination of having to use a blunt knife and my poor fine motor skills meant that whilst the cake was cut into more or less equal portions, each slice was a solid piece of cake plus a mound of crumbs. There was just time for all to enjoy the cake that they had patiently waited for. And very good it was too!

Linden Lodge School, London

[1].Names changed to preserve anonymity

What we planned; what we provided; what we did on the day; what they said; what will follow

SPECIAL NEEDS LONDON

Equals Workshop

Saturday 27 September 2003

Members of the Equals team - **Jane Gabb, Rachel Gibbons, Mark Pepper** and **Nick Peacey** - help teachers to reveal the excitement and applicability of mathematics to pupils who have in the past found it inaccessible and/or irrelevant.

What we planned

First we reminded ourselves of the aim of Equals. We decided that it might perhaps be best expressed in the words given above, which were used to introduce the Harry Hewitt Prize for work (presented by a teacher) of a student who has struggled and finally broken through.

Because *Equals*' specialist focus allows it to give precise practical advice on many aspects of Mathematics and SEN, backed with sound theoretical understanding we felt able to offer a session incorporating

- the thinking embodied in the best of government curriculum strategies;
- classroom practitioners' experience and ideas for approaching pupils' difficulties (which may at times be at variance with government thinking);
- up-to-date ways to create an inclusive classroom for all phases and in all types of school.

All the activities to be worked through during the session were based on material from past issues of *Equals*

What we did on the day

What Mark Pepper did (See *Equals* 6.1, p. 24 & 7.2, p. 21)

My session was in three parts:

- first – a workshop;
- second - a question and answer session with the whole group;
- third - and, unfortunately, very rushed - individual teachers asked questions informally.

Work with equipment

We discussed the advantages and disadvantages of the use of unifix and multilink cubes. One member of the group made a point that had not previously occurred to me. She said that she had a fairly boisterous class and that with multilink some of her class made guns whereas this was not possible with unifix. Practical considerations to try to minimise disruption are certainly worth bearing in mind. There was also a brief discussion regarding the use of Dienes blocks, The general consensus was that base 10 blocks were useful but it was not advisable to use blocks in different bases.(Some members of the group who were considerably younger than myself were not aware that Dienes blocks existed in bases other than in base 10).

What the group said to Mark:
Question and Answer session with whole group
One mainstream teacher said that she had difficulty in providing appropriate resources for one of her pupils who had a visual impairment(V.I.). A very useful resource to use in instances such as this is the V.I. Service which should be available within all L.E.A.s. A peripatetic V.I. teacher will give advice on issues such as presenting worksheets in large print or Braille and in presenting diagrams in tactile form. They will also provide advice on the provision of a learning assistant, classroom organisation and inset for staff and/or pupils in their relationships with a pupil with a V.I.

Informal Questions after the session
Several teachers were very concerned about the need to provide mathematics to students with S.E.N. One mainstream teacher said she had for the first time to present mathematics to a pupil with learning difficulties. The advice she had been offered was to "look at the P levels".
" Whatever they are," she said, shrugging her shoulders.
I felt a lot of sympathy for the plight of this teacher - an example of rushing to implement inclusion policies before the essential groundwork had been done. Clearly she should have been provided with detailed INSET on the P levels and on how to present a suitable mathematics curriculum for her student with learning difficulties.

What Nick Peacey did (See *Equals* 6.1, p. 14)

Our crowded but cheerful group did not have the time to go all the way with its allotted exercise, a spread from Equals around the issues raised by the coffee trade. But we quickly worked our way through many of the tasks. The subsequent discussion made clear that, despite the limits of the situation, a group such as ours could combine effectively and quickly to develop a capacity for thoughtful discussion. We worked on concerns raised by colleagues about classroom mathematics, particularly those stimulated by the exercise. We may even have resolved one or two issues! It was an encouraging half-hour and showed how valuable such professional reflection can be.

What Jane Gabb did (See *Equals* 8.1, p. 25 & 8.2 p.11)

My group worked through a couple of problems which had been presented in Equals – participants worked on handshakes and diagonals and were interested to see the connection between these problems. The L-shaped hexagon promoted some interesting comments such as "It's impossible!" and "You don't have enough information." When I challenged these assertions, the participants took another look at the problem and were able to see that actually they did have enough information - it just needed extracting, or if they didn't then they could generalise by using algebra.

Most of the group felt they could use the ideas presented with some of their classes, or could adapt them to use – they were generally positive about the materials.

What Rachel Gibbons did (See *Equals* 5.1 p. 11, etc.)

For many years Equals ran a feature "Calculating continued" and I had collected together a variety of these for my group to work on as they chose.

What the group did
Most of my customers needed no encouragement to start on one or other of the activities presented and the majority chose to work in groups of 2 or 3. They had some questions as I walked around among them but most recognised as they worked that they were being asked to use the calculator as a learning tool to explore number and were being encouraged to reflect on how numbers behave. They appeared to value the experience of being part of a learning group who were sharing ideas and could see that similar activities – using simpler numbers and in some cases simpler processes -could do the same for their pupils.

What they wrote

Questionnaire analysis
Some forty people worked with us on activities from Equals. Sixteen of these participants managed - in the outgoing rush while the queue for the next session waited impatiently to take over the room – to complete and return the questionnaires we had distributed. As the results will inform the future content of Equals we offer a brief analysis below.

Participants who responded
5 primary teachers
4 secondary teachers
5 consultants/advisers
1 language college teacher
1 teacher from Norway who had never taught mathematics but wants to start NOW

Characteristics of the learning groups with whom they worked

The size of the groups faced ranged from single pupils to classes of up to 30.

The ages of the students covered the whole primary secondary range while two participants taught adults.

The problems encountered in these learning groups included:

autism,
Downes syndrome,
dyslexia,
dysphasia,
EAL,
hearing impairment,
low literacy,
visual impairment.

Key questions they wanted answered

What is mathematics for special needs?
How do you provide fun and inspiration for those with special educational needs?
How do you counter children's lack of confidence, overcome their sense of helplessness?
How do you engage them with mathematics?
What resources can you use to make mathematics meaningful to them?
How do you ease the pressure exerted by parents?
How do you teach multiplication to dyslexics?
How do you differentiate?
How do you make effective use of LSAs?
How do you get spatial concepts across?
How does one move from concrete to abstract?

Areas they found most difficult to teach

- arithmetic
- course work
- fractions
- geometry perhaps
- inverses of +, x
- place value
- thinking/reading /understanding problems
- working with written materials which lack visual references or practical activities

Topics for future issues of *Equals*

- 2D shapes
- 3D shapes
- area
- data
- differentiation of classroom materials
- early P levels for S/PMLD pupils
- fractions, percentages and ratios
- geometry
- numeracy and dyslexia

What participants had learnt

Lots! reported one participant whereas one had, sadly learnt nothing new

For the rest:

- How to present relationships between shape and number to small groups
- Taking one problem, more ways to achieve answers
- To ensure that children are not worried about mistakes
- Ideas to activate pupils
- How to integrate child with global difficulties
- How to deal with different levels of achievement in one group
- Games and how to use them in small groups
- Maths can be fun
- How to work in groups
- How to use a calculator for learning
- With class working in groups, one group can show the rest of the class (the best way to learn)
- More about equipment, in particular the flexibility of the shubi abacus
- Not sure … something about practical work
- New ways to handle basic number work

Intended use of the activities experienced

Next week's Y8 lesson!

No one else was so specific but several participants saw the activities being useful for small groups.

What will follow

We decided that volume 10 of *Equals* should take further some of the questions asked by participants in our session and should offer help in areas of mathematics education they found difficult to present. Also references will be given to articles in previous issues of *Equals* which tackle some of the difficulties mentioned.

A copy of the booklist and the background advice we prepared for distribution will be included in Equals 10.2

Richest and poorest

Eight companies earn more than half the world's population.
One in five of the world's poorest people live on just one dollar a day.
For every £1 of aid put into poor countries, multinational companies take 66p of profit back.
The three richest men in the world are wealthier than the 48 poorest countries combined.
Over 12 million children under five will die from poverty-related illness this year
WDM (World Development Movement) leaflet July 2002

A challenging parent

It can be painful being a parent if you are also a teacher of mathematics. I have taken to wearing shin pads...

Here are some recent dialogues:

Dialogue 1

Parent: When do the children get an opportunity to do investigative work?

Teacher: We do an investigation in the summer term.

Parent: Only once a year? [*Kick, kick*]

Teacher: Yes we haven't really got the time as we have so much content to get through before the SATs.

Parent: How do you develop children's mathematical thinking then?

Teacher: [*Teacher pauses*] As they become more confident with their mathematics the thinking and the understanding will come. We believe children really must know the basics first.

To avoid more kicks and because I felt there was not a lot of mileage in pursuing this any further I pretended I was satisfied with the answer.

Dialogue 2

Teacher: J seems to have a few problems with his tables.

Parent: We would like to help him. How do you teach tables?

Teacher: Well, on Monday we go through a times table like the 4 times table, they copy it into the books and on Friday we have a test.

Parent: Sorry, I don't think you understand my question. How do you teach tables? [*Kick, kick*]

Teacher: I assure you it does work particularly if they get some help in learning them at home.

That put me in my place!

Dialogue 3

Parent: I was looking at J's book last night and I notice that he was getting questions wrong involving long multiplication of decimals.

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   2 3
 x 1.9
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 2 0 7
   2 3
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 2 3.0
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Teacher: *[Pointing out the correction she had made and the comment 'Don't forget to add zero']* Yes I noticed that. He was forgetting to add a zero – a common mistake.

Parent: I also noticed that when he didn't have decimals he was getting them right.

Teacher: Yes I noticed that too.

Parent: I asked him why he was doing what he was doing and his reply was 'I was multiplying by 1 not 10 so I didn't need to put a 0'

Teacher: Some children do find handling decimals quite difficult when they first come across them. They forget the rules.

Parent: I also notice that he has written down 3.2 x 5 = 1.6. *[Kick, kick]* When I talked to him about it he said that he thought the answer was 16 because 3 x 5 = 15 and 0.2 x 5 = 1 so the answer is 16 but he was puzzled that it didn't fit with the rule, *[shows the teacher the rule which had been copied off the board, that you count the number of decimal places after the decimal point in the question and that is the number of decimal points in the answer.]* He put a decimal point in between the 1 and the 6 to fit with the rule.

Teacher: Once he becomes more familiar with doing these types of calculations he won't make those mistakes.

I know my son's school has recruitment and quality of teaching problems just like so many other schools. I know that schools have to recruit unqualified teachers, overseas trained teachers who are familiar with a totally different pedagogy and many non-specialists whose subject knowledge might not be all that it should be.

As a member of the teaching profession I understand the difficulties. As a parent I don't want excuses and I don't want to teach my child myself *[Fellow parents/teachers will empathise with this comment]*. I just want my son to be taught properly even if it means going around on crutches in later life.

A question of calculators and order

Sue Clarkson & **Marion May** describe part of their initiative to raise the profile of transition from Year 6 to Year 7 in West Berkshire..

We have tried to attend all the primary liaison meetings that the Key Stage 3 co-ordinators have arranged, some of which have been well attended. Occasionally, however, only one or two schools have been represented. These meetings are always arranged as twilights, which we suspect is part of the problem of attendance, but which makes any real advances to transition very difficult.

Confusion occurs if the pupils in Year 5 and 6 meet a calculation with no brackets but need to follow the rules of order because the context demands it.

In recent meetings, we have used the information from *"Numeracy across the Curriculum", section 6 (Using Calculators in Key Stage 3 – OHT 6.2)* to lead discussions on the expectations of the Key Stage 2 and 3 Frameworks. It has since become increasingly evident that there is a mismatch between the two Frameworks, leading Year 7 teachers to have expectations of their pupils when using calculators that are often not borne out by reality.

The calculators in use in most Key Stage 2 classes follow arithmetic logic. If pupils use them to solve multi-step problems involving mixed operations, they either need to decide where brackets would be or solve one step at a time and use the memory, otherwise the calculations will be done in the order in which they are keyed in, giving an answer that may be incorrect. In Key Stage 3 the calculators follow algebraic logic and can do multi-step calculations applying the rules of order, and this is where some of the early misunderstandings arise.

In the primary framework the only indication of order is in the use of brackets: (Section 6, pages 53-55 'Use brackets: know that they determine the order of operations, and that their contents are worked out first'). In the Key Stage 3 Framework 'Know and use the order of operations,' (page 86) is a key objective for Year 7. The confusion occurs if the pupils in Year 5 and 6 meet a calculation with no brackets but need to follow the rules of order because the context demands it.

The following example may help to illustrate the possible difficulties:

4 + 6 x 5 would give an answer of 50 on an arithmetic calculator and would illustrate the following problem: *Joe collected 4 tokens from the local newspaper and 6 tokens from his magazine for 5 weeks. How many tokens did he collect altogether?* But what if the problem was posed thus:

Joe saved £6 every week for 5 weeks; his Dad then gave him another £4. How much did he then have altogether? Clearly, there would need to be some understanding of the order of operations and how this affects calculator use.

To investigate this further we approached a Year 6 teacher to ask if we could introduce them to different calculators, similar to those they would be using in Year 7. We devised a question sheet with columns for the pupils to put their answers directly from the calculator display (see sheet). We acknowledged that the examples were ones they could work out mentally, but that we wanted them to use calculators and that some of the answers would be different according to which calculator they used. The pupils used 3 different calculators:

- **Calculator A - a basic, arithmetic calculator**
- **Calculator B - an algebraic calculator with a 2-line display, showing the steps of the calculation**
- **Calculator C - a graphical calculator**

Calculators B and C both had the facility to enter brackets if these were present in the calculation.

The pupils worked in pairs and after every 3 questions we asked them to discuss their results and comment on those where the answers were different.

Gradually, through discussion, the children recognised that if brackets were present and they entered them exactly as shown, all calculators gave the same answer, but if brackets were not shown, calculator A gave a different answer from B and C. By discussion and questioning, after each "batch" of examples, we came to an agreement that calculators B and C were "doing" multiplication or division before addition and subtraction, if no brackets were present, but that calculator A just performed the operations in the order they were entered.

We were able to finish with a brief discussion with the children about the importance of order when interpreting word problems, along the lines of the examples above, and they had a brief go at writing their own examples.

IMPLICATIONS:

We intend to share the results of this session at future liaison meetings and also with primary co-ordinators and Heads of Mathematics departments. We hope to raise awareness in upper KS2 and in Year 7, that children transferring may not know the importance of order and may be confused by different calculators. There has even been some talk about extending the transition unit for mathematics to include some work with calculators!

Many thanks to the staff and pupils of Englefield School who made this project possible.

Calculation	Results		
	Calculator A	Calculator B	Calculator C
5 + 7 - 2			
5 x 6 + 3			
3 + 6 x 5			
12 - 3 + 9			
(5 + 8) x 5			
5 + 8 x 5			
18 + 10 ÷ 2			
(18 + 10) ÷ 2			
4 x 5 x 3			
25 - 10 ÷ 5			
14 + 5 x 10 + 2			
(14 + 5) x 10 + 2			
25 ÷ 5 + 10			
10 +25 ÷ 5			

You have 3 calculators to try with each calculation. In some cases the answers you get will be different. Can you work out how each calculator is operating?

Did you know?

22 million children worldwide are severely overweight (World Heart Federation)
5-15% of children in the UK are brought up to be overweight (British Nutrition Foundation)
On average British children are eating **less than half** the recommended five portions of fruit and vegetables per day (National diet and Nutrition Survey June 2000)
The **majority of children** and young people in the UK have adequate intakes of most nutrients (National diet and Nutrition Survey June 2000)
10% of 15-18 year old girls are vegetarian or vegan and 1 in 6 diet to lose weight (National diet and Nutrition Survey June 2000)

Children growing up in disadvantaged families are about **50%** less likely to eat fruit and vegetables than those in high-income families (National Fruit Scheme website)

The Local Authorities Catering Association estimates that **2.5 million** school meals are served daily in England (British Nutrition Foundation website)

Governors, DfEE, October 2002

Reviews

Review Anne Marsh

Murderous Maths: Algebra The Phantom X.
Kjartan Poskitt, Scholastic Children's Books
ISBN 0 43997729 0

I've read a lot of maths books in my day. Take the one I'm using in preparation for my GCSE, for example. It states "Algebra is a method of calculating, using letters to represent the numbers and signs to show relationships between them, making a kind of abstract arithmetic."
This book states "Algebra is a way of doing sums when you don't know what all the numbers are – so you use letters instead."
I don't know about you, but I know which definition makes more sense.
My dad handed me this book after a visit to the Science Museum and, after reading many of the other Murderous Maths books by Poskitt, I knew about them being very informative with a really good stab at being funny, and with these thoughts in mind I was hoping to enjoy it. I was not disappointed.
After the initial greeting by a shadowy figure only known as "X", this book made me understand algebra more than anyone, ever, has made me understand it. It takes you through each equation and method (including simultaneous equations) step by step in a series of hilarious mini-stories featuring characters that wouldn't even go near a textbook.
One story in particular is brilliant, and that is the sections on factorising and quadratics. These two words usually spark fear into any GCSE student who reads them, but this section is not only hilarious, but includes the infamous "Murderous Maths Quadratic Cracker". This is only my opinion, but EVERY SINGLE secondary school classroom should blow this up and stick about three of them in every maths room. It is a simple flow diagram taking you through how to factorise things into two brackets. What happens when they don't? Hit the Panic Button of course!
Not only does this book make algebra easier to understand and remember, it also makes it fun and in my experience, anything that can make algebra fun deserves a pat on the back at the very least. As the book states: "Even if you don't quite follow it, fold the book open on these pages and then casually drop it in front of somebody. When they pick it up and see that you've been reading about quadratic equations, they will think you are utterly brilliant. You'll get top credibility points at no personal expense – and not many books can do that for you." Which just goes to show..........

Burnham Grammar School

94 per cent of 12 to 17-year-olds have mobile phones. Sixty-seven per cent have computers and regularly surf the internet. Both of these figures are far higher than in America. …one in five online under-17s used porn sites – for an average of 28 minutes.
Geoff Barton, "Who will play big brother?" TES 13/09/02

London is a very rich city but 41per cent of children are living in poverty, 53 per cent in Inner London.
Ellie Levenson, Fabian Review, December 2002

50% of prisoners have lower reading skills than 11-year olds; 65% lower numeracy skills; and 80% lower writing skills…Since[the 1991 riots] the prison population has risen from 45,000 to 72,000 and is projected to reach 100,000 by the end of the decade. Building extra prisons is not the solution.
Leader, *The Guardian*, 21/12/02

A secret UN report predicts:
500,000 civilians are likely to die or be injured in a military assault on Iraq…
another three million will face "dire" malnutrition…
there will be 900,000 refugees and the damage to the people and the nation's infrastructure will be much greater than during the 1991 Gulf conflict.
Mark Ellis and Lorraine Davidson "Saddam will 'fight to end', Daily Mirror 9/1/03