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Making maths memorable, accessible and relevant

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Chapter 1
What is Numeracy?

On occasion, I've seen grown adults reduced to a quivering heap by maths. Although this might be an extreme reaction by the unfortunate few, the word 'maths' seems to have become almost a swear word for some people. Many maths phobics draw on negative memories of school maths lessons and baffling concepts such as algebra or logarithm tables. Recollections like these are often where lifelong problems with maths begin.

However, there is a real issue in some educational establishments which treat numeracy as the estranged cousin to literacy. The thinking goes that so much of our lives rely on computers and algorithms to do things for us, that a basic knowledge of maths is no longer necessary, and, as such, maths gets placed on the back burner. This has disastrous consequences. The number of people who are innumerate is growing steadily and this needs to be tackled in the early years at school. With qualifications in subjects such as geography and science acquiring heavier maths core skills content, this reason alone should motivate us to embed links to numeracy across the full curriculum.

We live in a culture in which people go to extreme lengths to hide the fact that they can't read or write. Bizarrely, however, it is deemed socially acceptable to say, 'I can't do maths' or 'I'm no good at maths', and then do nothing about it. It's easy to forget the damaging effects that repeating those simple words to yourself can have on the growing mind; it then becomes a self-fulfilling prophecy. Parents, teachers, celebrities, even movies and advertising campaigns, may often deliberately or unconsciously promote people's perception that it is okay to be rubbish at maths.[1]

So, how can we expect students and the future leaders of tomorrow to hold maths and numeracy in high regard when society is continually telling them that being bad at maths is acceptable? According to a YouGov poll commissioned by the charity National Numeracy, regardless of the participant's level of the

1 See R. Garner, Shame celebrities who boast about poor maths, says numeracy charity, *The Independent* (15th September 2014). Available at: http://www.independent.co.uk/news/education/education-news/shame-celebrities-who-boast-about-poor-maths-says-numeracy-charity-9734152.html.

subject, 80% either strongly agreed or agreed with the statement, 'I would feel embarrassed to tell someone I was no good at reading and writing.' However, only 56% of people either strongly agreed or agreed with the statement, 'I would feel embarrassed to tell someone I was no good with numbers and maths.' However, the issue is even more prevalent with females: 82% saying they would feel embarrassed to tell someone, 'I was no good at reading and writing' and only 53% saying they would feel embarrassed to tell someone, 'I was no good with numbers and maths.'[2] This is a 29% difference with the female sample compared to the male sample, where the difference was only 18%.

In failing to change this culture of ignorance, we are handicapping ourselves for the rest of our lives. No matter how much we might loathe mathematics, we need to acknowledge that we all use it on a daily basis. We are surrounded by mathematical concepts all day, every day. Therefore, we need to change the passive acceptance of failure and find every way possible to support students to overcome their maths hang-ups.

It is the job of the teacher to be not only numerate themselves, but also to recognise and respond to any numeracy weaknesses in their students. It is only in this way that progress will be made, and this has to happen in *all* areas of the curriculum as well as in everyday life out of school. As a result, students become more competent and are more likely to buy into their learning.

The first part of this process is to make it acceptable to admit to poor numeracy skills, as that is the basis for doing something about it. The acceptance of poor numeracy skills is different from the proud declaration of not being able to do maths which can lead to students who won't try and who seem not to care. There should be no shame – or glory – attached to a student's admission. Instead, it should be seen as part of learning to do better, demonstrating a growth mindset and the foundation of future success in life.

2 See http://cdn.yougov.com/cumulus_uploads/document/tm2q3p27f6/Results-for-National-Numeracy-Numeracy-10032015.pdf.

Why maths matters

Although it is not possible to be definite about how the working environment will change in the future, we can be certain that it will change, and that some kinds of work will be taken over by automation and artificial intelligence, reducing the amount of skilled and semi-skilled work that we became familiar with in the 20th century.

In other areas jobs will rise. The National Careers Service predicts that 'Employment in the trade, accommodation and transport industries is expected to increase by 400,000 jobs by 2020. Much of this growth will be in distribution, retail, hotels and restaurants.'[3] This means that in the future there will be an increasing need for people to work in catering services; social services; sport, leisure and tourism; transport; storage, dispatch and delivery; and retail sales. All of these require numerate workers, capable of measurement, timetabling, costing, statistical analysis, networking, accounting and forecasting. In addition, many people will be expected to be fluent in computer technology and able to write their own algorithmic software programs.

If the UK is to continue to develop economically, then today's students need to understand the relevance of numeracy, and that unless they are able to participate in future developments in technology, they will find it difficult to get work. Research carried out by Pro Bono Economics, drawing on a number of factors, estimates that low numeracy levels cost the UK £20.2 billion (1.3% of GDP) each year.[4] A massive 68% of employers are concerned about their employees' ability to understand if the figures presented to them make sense – what is commonly called a 'sense check'.[5]

So, maths really does matter in the current climate, and for the future if the economy is going to grow and adapt to changes in technology and working practices. As educators, we need to make sure that companies have faith that

3 See UK Commission for Employment and Skills, *Working Futures 2010–2020. Evidence Report 41* (August 2012). Available at: http://webarchive.nationalarchives.gov.uk/20140108090250/http:/www.ukces.org.uk/assets/ukces/docs/publications/evidence-report-41-working-futures-2010-2020.pdf.

4 Pro Bono Economics, *Cost of Outcomes Associated with Low Levels of Adult Numeracy in the UK. Pro Bono Economics Report for National Numeracy* (2014). Available at: http://www.probonoeconomics.com/sites/default/files/files/PBE%20National%20Numeracy%20costs%20report%2011Mar.pdf, p. 4.

5 National Numeracy, *Numeracy Review* (Lewes: National Numeracy, 2015). Available at: https://www.nationalnumeracy.org.uk/sites/default/files/numeracy_review_overview_v2.pdf, p. 2.

our young people have a sufficiently high level of mathematical ability, so they remain highly employable in both the national and global market. Improving numeracy within schools is a fundamental way of developing core skills.

Numeracy is the stepping stone that allows students to access mathematics. It is, if you wish, a subset of mathematics. Numeracy is the basic ability to recognise and apply simple mathematical concepts to solving problems in everyday life. It includes basic skills such as addition and multiplication, which enable us to handle common functional maths topics such as weighing ingredients and telling the time. In contrast, the more complex domains of mathematics – such as algebra, trigonometry, calculus or topology – are a minority interest and most people leave them behind in the classroom.

However, mathematical reasoning provides a way to develop the mind and train the thought processes needed for problem solving. It is these basic skills that transfer to real-world problems. Some of the topics learned in the maths classroom may seem irrelevant, but it is important that we develop the analytical and logical thinking skills which will support future learning and comprehension.

Figure 1.1 demonstrates how numeracy underpins the resources and principles in this book. In short, without the foundation of numeracy, students will be unable to understand or fully access the world around them.

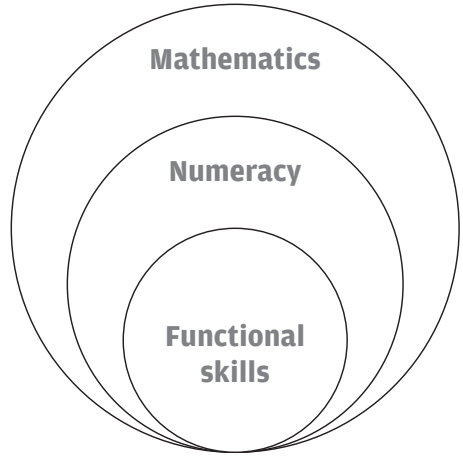

Figure 1.1

It's not okay to be innumerate

There is a social stigma attached to calling someone illiterate, but this does not apply to being called innumerate. This could be because the need for literacy is an essential everyday requirement. If you can't read you will struggle to perform many tasks that others find easy. It soon becomes obvious to others that you can't read because you can't understand written information – for example, that key aspect of modern life, the ability to send and receive texts. Literacy, unlike numeracy, is a visible skill that students can observe everywhere they go from a very early age. Conversely, many numerical tasks are performed automatically, such as on cash-registers in shops and online payment systems, and this seems to remove the requirement for mathematical competence.

Numeracy is often a more hidden skill that lurks in the depths of daily tasks. Young children can get by without a basic level of numeracy, but as they grow older the need for competence in numbers becomes an essential part of getting a job and in taking on the responsibilities of a householder. Numeracy is no longer a hidden skill.

Herein lies the basic problem. Students can't comprehend what is needed in the future if they don't know what to expect. Just telling them isn't good enough. They need a clear understanding of why they are being asked to do things, and for many hard-core students who refuse to admit a need for numeracy skills, seeing is believing. Unfortunately, many students only realise the purpose and need for basic numeracy skills too late.

It is therefore essential that, as teachers, we provide opportunities for students to understand why they are doing things and the benefits they will get from learning particular aspects of numeracy. Unlike GCSE mathematics, where students study many things that they will probably never use again afterwards, it is important to place the need for numeracy in context as an essential life skill *before* we begin to teach the specific techniques they need to acquire.

There are two types of numeracy issues with students. The first is with those who can't be bothered to learn the skills because they can't see the purpose of them. The second is a much more delicate situation. It concerns those who struggle with mathematics and who may even suffer from dyscalculia. These students may get a lot of support and encouragement, but unfortunately – given the way the education system is set up – this is often designed to help them

keep up with the material that other students are studying. Because they are moving at a pace too fast for deep understanding, these interventions can lead to ever more superficial understanding, with many gaps and little retention.

The core principle of numeracy is for the foundations to be secure. It's the same as building a house in an earthquake zone: if the foundations are dug deep enough and the building constructed with the right materials, the house will be much less likely to collapse. In practical terms, the way to do this – instead of doing what the curriculum dictates, which is continually pushing forward those students who struggle – is to go *backwards*. This means playing with the games and activities in this book and using mathematical equipment to help embed and support the principles of teaching for depth carried out by the maths faculty. This will help to ensure that students understand the most basic number skills, with no tricks or gimmicks. When done correctly, students will have a greater rate of retention with mathematical topics.

I started this 'back to basics' technique with students in my second year of teaching. I have found that when it comes to teaching mathematics, schools often give the lowest ability Key Stage 4 groups to the newest teachers. This is certainly what happened to me. I took on students who were all predicted U's or G's, and I have to admit that I didn't succeed with all of them. However, by applying the principles above, I managed to help motivate one student to access enough content to gain a grade C and several others achieved D's and E's. There were no longer any U's, but some never got beyond F's and G's. I applied this same principle again the following year with a similar set with even more success. However, it took a lot of buy-in at this stage to improve a bottom set at the start of Year 11. But imagine if these principles were applied early on: how much more would the students be able to access? Would they learn to love maths instead of loathing it?

Another problem with a lot of maths teaching is that students are instructed about the mathematical techniques and operations without being provided with a clear understanding of the purpose or desired outcome – that is, what you want to do and what kind of answer is expected. In other words, the big picture is missing. Therefore, the teacher needs to explain *why* they are doing these things and what benefit they will get, rather than merely concentrating on the nitty-gritty.

As a maths teacher, one of the most common things I get asked is, 'Miss, why will I need this?' or, worse, I am told, 'I will never need this in real life, what's the point?' However, I've often found students to be extremely curious, and they are not being deliberately awkward in asking these questions. Since they have to learn and retain so much information on a daily basis, of course it is important that they prioritise what they are taking in. I have discovered that the best way to do this is to show students non-hypothetical examples of where they will use elements of mathematics in real life – I will cover many examples in this book. I am also honest that the likelihood of them using particular skills in life is slim, such as the sine rule or the cosine rule, but I do go on to explain the reasoning behind why it is still important to learn it and the significance of the thought processes it builds.

A key example of this understanding clicking into place for a student of mine was when he was completing a Duke of Edinburgh's Award scheme trek. This meant they would have to use a map and compass to find their way. As I knew that this student would be on the trek, I thought this would be a great time to tackle his stubbornness as a mathematics learner. So the week before I made sure I covered bearings and map-reading skills. On returning to school the following Monday, the student was in awe that his maths lesson had actually helped him with something tangible – in his words, 'It totally wasn't maths, Miss, but what we did helped us not get lost.' We then followed up this statement and had a brief class debate on how sometimes the things we least expect to be of use can actually help us the most.

There are many ways in which elements of a maths lesson can instantly relate to a student's everyday life experiences. Here the students get to see numeracy in action and can relate to the awe of the student described above.

Numeracy in action 1: shopping

Students need to be able to leave education with the ability to handle the tasks of everyday life. Some are unable to deal with simple monetary amounts; others struggle when they need to accurately scale a recipe up or down when cooking for more or fewer people than is stated in the recipe. These are everyday skills that students often don't link to mathematics.

Now, if they can't calculate monetary amounts, how do they know if they are being ripped off? For example, Figure 1.2 shows some genuine shop price labels. I've shown these to staff and students and asked them to spot what is wrong. Sometimes it takes a while for them to understand what the mistake is and how they are being misled.

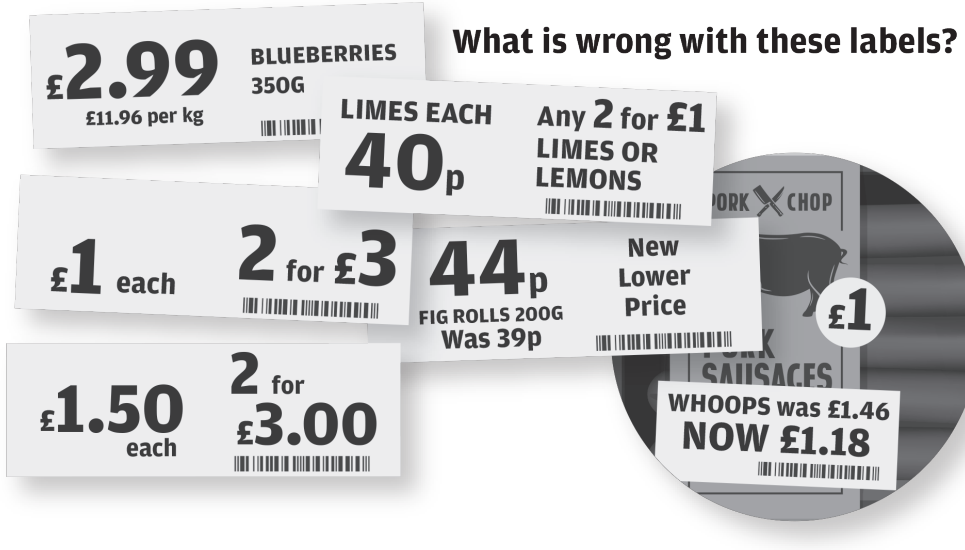

Figure 1.2

These labels all show errors of one kind or another, but I wonder how many students would realise this and check the calculations. For example, the offer of 40p each or two for £1 means students would need to calculate a very simple sum to work out that it is actually cheaper to ignore the two-for-one offer.

How often do we miss these mistakes ourselves when shopping? Comparing the price per 100g or per 100 sheets of toilet paper is an essential skill, and enables us to get the best value for money rather than being deceived by pseudo offers. When you have a limited budget, every penny counts. Being able to calculate unit pricing is a vital numerical skill that students need to master. This comes down to their number sense and problem-solving skills. For example, they need to understand that 10.5p is more than 10.05p. I've purposefully used this

example as it is a common mistake students make when attempting to put decimal numbers in ascending order.

Stores often try to direct customers to offers or multi-buy deals that they want to promote, but they also place a premium on those brands and products which earn brand loyalty from consumers. How many of us regularly calculate the benefits of each offer when a supermarket places rival offers from well-known brands on an end-of-aisle display?

Figure 1.3

Let's have a look at an actual choice in a supermarket (Figure 1.3). Which offer would you go for? How long would you spend evaluating the alternatives while standing in the aisle? Many people go for speed and purchase the 'Puppy' offer. It looks like a clear bargain: you gain the third pack for only £2.50. But is it really a bargain?

There are three different levels of analysis you can use for comparing these types of offer. The first technique for making a fair comparison is to calculate the price per roll. Many students will write and calculate the division the wrong way round. For example, to find the unit price of 'Silk' toilet roll they calculate 24 ÷ 7, instead of 7 ÷ 24, often because they believe you always divide by a smaller number. Other students may not even realise that they need to divide.

Panda toilet roll	**Puppy toilet roll (3 for £10 offer)**	**Silk toilet roll**
9 rolls costs £3.50 £3.50 ÷ 9 = 0.38**89** 1 roll costs **39p**	27 rolls costs £10 £10 ÷ 27 = 0.37**04** 1 roll costs **37p**	24 rolls costs £7 £7.00 ÷ 24 = 0.29**17** 1 roll costs **29p**

Note: All rounded to two decimal places.

From the calculations, 'Silk' is clearly the best offer by a long way, but do you get more or fewer sheets per roll (PPS or price per sheet)?

Panda toilet roll	**Puppy toilet roll (3 for £10 offer)**	**Silk toilet roll**
1 roll with 180 sheets costs **39p** **PPS** = 39 ÷ 180 = **0.22p**	1 roll with 160 sheets costs **37p** **PPS** = 37 ÷ 160 = **0.23p**	1 roll with 200 sheets costs **29p** **PPS** = 29 ÷ 200 = **0.15p**

Note: All rounded to two decimal places.

This second level of analysis, for students who understand place value, provides an opportunity to compare products more accurately and in depth. The calculations show that 'Silk' is the best offer by a significant margin.

The comparison per roll shows that 'Puppy' seemed to be better value than 'Panda'. However, the more in-depth per sheet calculations show that the 'Puppy' offer isn't as good as the 'Panda' offer. Supermarkets often write these comparison figures in small print on the product labels.

When you are in a supermarket, how much time do you spend comparing products in terms of the *quantity* of the item you get, whether it is eight chocolate bars or nine toilet rolls? Do you work out how much product you are getting in precise detail, or do you simply assume that the products are like for like?

How many times have you heard someone say they 'can't do maths'?

This attitude and acceptance of it appears to be endemic, but being bad at maths – or excusing innumeracy as maths-phobia – can no longer be tolerated.

Danielle Bartram has made it her mission to remedy this issue by making numeracy count in every classroom (not just in the maths department!), and in *Forty Pence Each or Two for a Pound* she shares an invaluable collection of practical, ready-to-use resources that will enable teachers to combat students' fear of maths and bring numeracy to the heart of the school's curriculum.

Brimming with cross-curricular ideas held together by six numeracy links – number, functional skills, graphs and statistics, problem solving, shapes and measures, and formulae and equations – *Forty Pence Each or Two for a Pound* gives the teaching and learning of numeracy a firm foundation in everyday contextual settings and makes maths memorable, accessible and relevant to all.

Suitable for teachers of all subjects, in both primary and secondary settings, who want to embed into their lessons the numeracy skills that their students will need in everyday life.

Forty Pence Each or Two for a Pound provides a vast array of mathematical content, practical ideas and effective assessment and classroom-management strategies designed to engage learners and increase whole-school participation in maths.

Ross Morrison McGill @TeacherToolkit

The essential guide that anyone with responsibility for numeracy in their school will want.

Mark Anderson @ICTEvangelist, Director, ICT Evangelist, educator, speaker, consultant, award-winning blogger and author

The wonderful Danielle Bartram makes numerical literacy accessible to all in this masterclass which explains numeracy in context and gives it the boost needed to compete with its literacy cousin.

Deborah Barakat @mrsmathia, Assistant Principal and Initial Teacher Training Lead, Excelsior Academy

With 31 activity types discussed, complete with teacher notes and variations, numeracy will no longer feel like an inconvenient bolt-on for non-maths teachers.

Craig Barton, maths teacher, maths adviser, *TES*, creator, mrbartonmaths.com

Invaluable reading for anyone promoting numeracy across a school curriculum.

Julia Smith, author and freelance maths teacher-trainer

In this helpful book, Danielle offers her top tips and provides some really practical, flexible lesson ideas to nurture numeracy in classrooms across the school, not just in the maths department.

Chris Smith @aap03102, maths teacher, Grange Academy, member of the *TES* maths panel and the Scottish Mathematical Council

Danielle Bartram is a maths lead practitioner and numeracy coordinator with a genuine passion for her subject. She developed the national campaign #Numeracy4All, regularly presents at events across the country, and is also a member of the UK *TES* maths panel and of the AQA expert panel. Danielle has designed resources used by thousands of teachers around the world and tweets @missbsresources.

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