Equals

Realising potential in mathematics for all

for ages 3 to 18+ ISSN 1465-1254

Vol.23 No.2

Old Bangers

Equals

Realising potential in mathematics for all

Letters and other material for the attention of the Editorial Team to be sent by email to: edmiston01@btinternet.com

Advertising enquiries: Janet Powell
e-mail address:
jcpadvertising@yahoo.co.uk
Tel: 0034 952664993

Published by the Mathematical Association, 259 London Road, Leicester LE2 3BE
Tel: 0116 221 0013
Fax: 0116 212 2835
(All publishing and subscription enquiries to be addressed here.)

Designed by Nicole Lane

Editor's Page

This edition sees the inclusion of a wide range of articles, two from contributors new to *Equals*:

- Louise Needham shares her vision for the development of mathematics in the New Bridge group of schools and,
- Sue Knox shares a dice game she uses to help her pupils develop their understanding of percentages.

We also see the return of Jane E who relates more of what it's like to teach in a hospital. Both Pete Jarrett and Mark Papper explore some of the ideas that underpin the mastery approach. I think this is timely given so many schools are adopting 'mastery' without thinking carefully of the implications associated with this approach to mathematics.

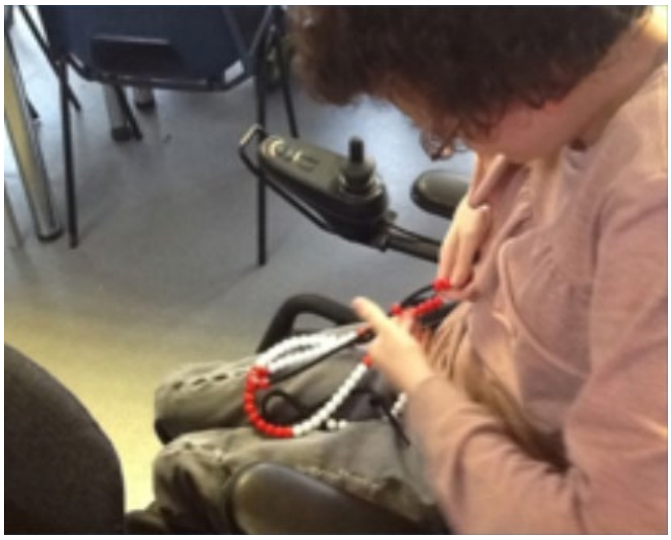
A range of practical ideas are shared by Mark Pepper, Sue Knox and Alan Edmiston. The final two articles by Alan Edmiston and Mundher Adhami focus upon the GAIM resources, which will be made available to all interested readers. For those of you who would like access to the GAIM resources please email: equals@m-a.org.uk. Please also use the same address to send any ideas or thoughts you would like to us to share.

We are now on Twitter so please follow us @EqualsOnline. When I tweeted to announce the next edition of *Equals* I suggested that people; read, reflect and respond. The latter action is growing as the proportion of articles that comes from those who are not part of the editorial team of *Equals* is rising with every edition. The move to have a Twitter presence emerged as a consequence of SEND Saturday, which took place on the 16th June at the Institute of Education in London. The day will feature in the next edition but what was clear is that there is a significant need for a network to support all of those who seek to support the least able. *Equals* is well placed to provide such a network and so watch this space for more events such as SEND Saturday. If you would like help or advice from *Equals* then pleaes get in touch: equals@m-a.org.uk.

Using concrete manipulatives to re-engage disaffected learners in maths.

Louise Needham **is the maths lead for a group of schools who support a wide range of learners. She has kindly taken the time to outline the approach to the teaching of mathematics that underpins her vision for the learners in her care.**

The New Bridge Group caters for young people with a statement of SEN or an EHCP from the age of 4 to 19. The New Bridge School converted to a Multi Academy Trust in 2014 to enable the sponsorship of a new build school for children on the autistic continuum, Hollinwood Academy.



In 2016 Spring Brook School then successfully applied to join our Trust and a free school, the Springboard Project was then set up, to deliver a more appropriate vocational offer for young people with SEND. More recently, Hawthorns school has joined our academy. During this academic year, the trust has been looking at how concrete manipulatives can be used to re-engage learners with mathematics as a project for Maths Hub North West 2.

Often when children arrive to our trust, they are very reluctant learners in maths and have totally disengaged with the subject. Children do not understand the abstract ideas in maths and it is an inaccessible subject. Children have high levels of mathematical anxiety due to previous experiences

with the subject. It is then up to the deliverers of maths at the Trust to break down these barriers to learning and ensure that all children make progress in maths.

One of the biggest barriers to learning is that children do not understand the abstract world of mathematics. Some children have learnt by heart mathematical rules, but they do not understand what they mean, and therefore cannot apply these rules to problem solving and reasoning questions.

During this academic year the Trust has had a huge focus on the use of concrete manipulatives in maths lessons. Staff have had training on the use of dienes blocks, place value counters, fraction and algebra tiles, interlocking cubes and other concrete resources. We have seen a huge impact in the use of these resources in maths lessons and re-engaging learners with their learning. Lesson observations have improved and pupils' progress in maths has increased significantly.

The majority of topics in maths are now started with the use of concrete resources (across all key stages) so that pupils can formalise their own mathematical reasonings and are able to make their own links with the abstract world of mathematics at their own pace. This is fundamental in the learning process of children with SEN because children with SEN generally have a lower working memory, can have higher mathematical anxieties and generally need a longer period of time to process their learning. Maths is a very fluid subject consisting of many different parts. Generally if a pupil doesn't understand one area of maths (for example place value, or fractions) this can have a knock on effect to other areas of maths.

Many people will say that maths is different from other subjects because it is a subject of right or wrong answers and this can also contribute to stress and anxieties because they don't want to get things wrong; but this is incorrect, and part of the change we need to see in the way that mathematics

is delivered is the acknowledgement of the creative and interpretive nature of mathematics. Mathematics is a very broad and multi-dimensional subject that requires reasoning, creativity, connection making, and interpretation methods; it is a set of ideas that helps illuminate the world; and is constantly changing. Around 25% of learners in any classroom are likely to struggle with maths at some point during their education. Most of the time, these difficulties can be overcome with a little extra support and some tailored intervention. Often the reasons for these difficulties is that maths has become too abstract too soon. Concrete materials are taken away too prematurely. This happens frequently after KS1 because pupils are not allowed to use concrete materials for the KS2 SATs and pupils need to prepare for the assessments, concrete resources can sometimes be seen as 'babyish', however resources like Dienes blocks and Cuisenaire rods can often have a more 'grown up' feel with older pupils.

Children that arrive to our Trust from mainstream schools have often become disengaged with education, have had poor attendance, and some were 'non-attenders'. This has massive implications when trying to assess their prior knowledge because they have lots of gaps within their learning and it can be very hard to catch up. Again, this relates to the fluid nature of mathematics and topics within maths which are intertwined. When one topic is missing from their learning it can often be hard to bridge the gap. Hence, this is why introducing concrete manipulatives across all key stages is essential so that pupils are given their own opportunities to formalise their own mathematical reasonings.

Information is taken into the brain through three main channels: visual, auditory and kinaesthetic. Many pupils with SEN have a weakness in one or more of these areas. Teaching in a way that uses all three of these channels will ensure that weaker areas are supported by stronger ones.

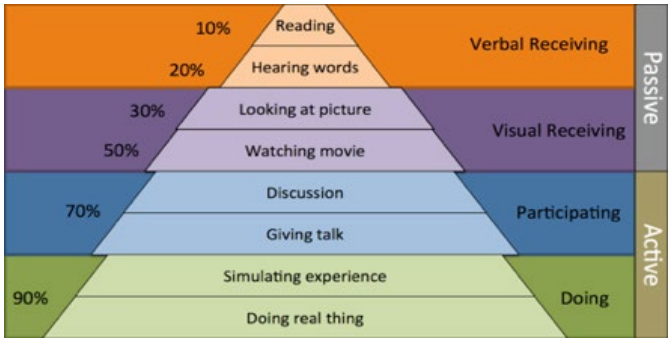
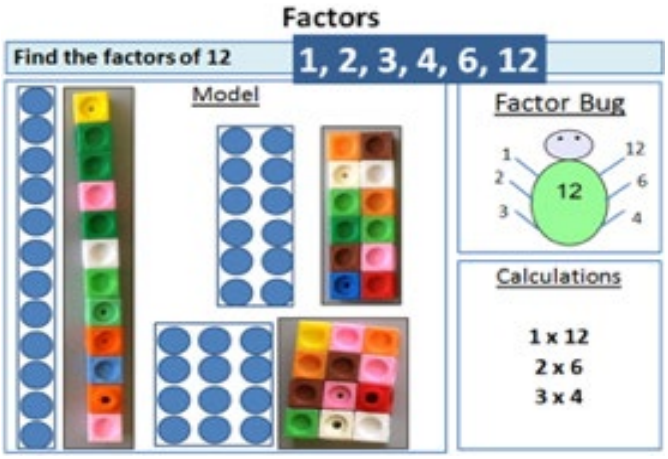


Image taken from: http://medtechmedia.com/files/emails/images/Herasevich_chart_201409CII.png

Varying the ways in which a topic is taught will ensure that the pupil will more likely to understand it and will go into the pupil's long term memory. For example, when teaching factors, it may be difficult to understand the concept of multiplying numbers (especially if the pupil is not fluent with

times tables). One strategy might be to draw the different rectangles that would give an area of 12 (hence making link between factors, side lengths and area). This could be strengthened by using interlocking cubes to manipulate the rectangles.



This resource can be downloaded from:
https://www.tes.com/teaching-resource/factors-using-modelling-concrete-pictorial-abstract-11412241

Examples of how the concrete Manipulatives have been used in maths lessons.

Dienes Blocks

Examples of how they've been used and comments from deliverers.
To highlight how **same value can be represented differently**.
Place value we used these so much! We have used these to build solid place value knowledge and the learners have **made so much progress**!
Addition, column method - helps the students to **understand 'carrying'**. Subtraction, column method - helps the students with decomposition.
Used to **generate up to 4 digit numbers** and for **visualising capacity**.
Place value, Colum Addition & subtraction - students were able to visualise the abstract concepts making it **easily accessible**.
Again this resource was a hit in KS3 class. The boys loved using them to find various ways of presenting place value. They even asked if they could play with them in their spare time.

Examples of how they've been used and comments from deliverers.
The blocks have aided my students with addition and subtracting. Allowing them physically carry out equations and see what is happening.
Number bonds - LA students - the different colours made it easier for the students to identify the number bonds easier.
Pictographs - different colours to represent the different criteria.
To help understand the concept of Averages.
Simple addition and subtraction - students can physically make the number sentences.

I used them in KS1 Maths lessons as non standard units to measure weight and length of various items. The children loved the idea of using cubes instead of a ruler and felt it was more fun too! All the class got involved in measuring.

Place value / number - concrete manipulatives allow hands on approach to maths, breaking down the threat of larger numbers.

Fractions of Amounts.

Simple division reminders.

Counting in tens - students were able to visualise the quantities whilst chanting - measuring the height of students, then counting in tens

Volume of 3D shapes - students were able to make the shapes from the 2d representation from a worksheet and then calculate the volume, the following lesson they were able to progress on to using no cubes.

Examples of how they've been used and comments from deliverers.

I have used these with my more able students. They have allowed students to gain a better understanding of 3 digit numbers.

Place value - helps the students to understand that each number has a value. Helps the students to read and write number. 605 helps the students to understand there are no tens within the number.

Addition, column method - helps the students to understand 'carrying'
Subtraction, column method - helps the students with decomposition.

Fractions and percentages.

Multiplication of 10, 100, 1000.

Multiplication & Division

Place Value (expanded forms)

The class consists of boys who are quite low level and each lesson they feel anxious that they might not be able to successfully complete their tasks. These counters engaged all the boys and made the level of anxiety literally insignificant.

In the place value module children used these enthusiastically because they were able to 'see' how place value worked they also used them in addition lessons after the blocks were no longer useful because of the amount needed. It helped them to understand the concept of carrying.

The concrete, pictorial, abstract approach to teaching and learning mathematics. Does it fit in the secondary classroom?

In this piece Pete Jarrett provides some very helpful advice on an approach to teaching that many people are talking about.

Both concrete manipulatives and pictorial/graphical representations of arithmetical concepts have been used in the classroom for many years. More than that, concrete and pictorial representations of number are foundational in developing understanding of a sense of number and the principles of cardinality and ordinality. It is no coincidence that we use a less than ideal base ten system and that we have generally have ten fingers.

More recently, a structured approach to the use of concrete, pictorial and abstract representations has emerged (or re-emerged, depending on historical interpretation). The concrete, pictorial, abstract approach (CPA), which is a core component of 'teaching for mastery' approaches in Singapore, has become the pedagogical model through which we describe this approach to maths teaching and learning.

The CPA pedagogy may not be an approach that sits comfortable in many Secondary classrooms. There is a tendency to teach in the abstract because we test in the abstract. Additionally, some learners feel that concrete approaches are less age appropriate – less mathsy. But for learners who struggle it can help to make connections that haven't been made before, develop understanding and improve engagement. The key lies not in the component parts of the CPA approach but in the way the route through from concrete to abstract is blended – known as concrete fading.

Fyfe et al. (2014) suggest four benefits of concrete fading (pg. 9):

1. Helping learners interpret ambiguous or opaque abstract symbols in terms of well-understood concrete objects;
2. Providing embodied perceptual and physical experiences that can ground abstract thinking;
3. Enabling learners to build up a store of memorable images that can be used when abstract symbols lose meaning;
4. Guiding learners to strip away extraneous concrete properties and distil the generic, generalizable properties.

Sharma (NCETM, online) identifies six levels of mathematical knowledge; the intuitive, that is the pre-requisite knowledge that the learner brings to the subject; the concrete, real things or tangible conceptions; pictorial, graphic representations that begin to blend towards the abstract; the abstract, using the symbolic notation that describes mathematics; Application, where the newly learnt knowledge is used in a variety of contexts; and finally, communication, where the learner is able to communicate their new knowledge to others.

It is helpful to view the application and communication of new knowledge as the demonstration of mastery of the new knowledge. The CPA approach moves us towards mastery, but only if the pre-requisite skills are there.

One of the difficulties in teaching for mastery is that the pre-requisite skills may be poorly formed, or misconceptions may have developed. Ideally, we need to work back efficiently to these areas of weak knowledge, confusion or misconception.

It's usually at this point that I insert the reader voice – something along the lines of "ideally, yeh, right! I wish!". To which, I generally nod sagely, offer some weak empathetic utterance, and suggest we can only do what we can, but sometimes we need to stop and think about what we do.

The thing is, if the learner is struggling with the abstract, we need to help them to build a representation of what they are trying to do. We need to move them away from their default "show me what to do and I will try and remember what to do" because procedural fluency does not work well if there is no conceptualisation. We, and the learner, also need to recognise where the real gaps in knowledge lie. Often much further back that we may guess. The laws of arithmetic, zero, the concept of =, place value, and a sense of number; that 13 + 17 is 17 + 13 or 13 + 10 + 7 or 10 + 10 + 7 + 3; and, if this is true, that 30 -17 must be 13.

sometimes we need to stop and think about what we do

One area of frequent struggle exists around fractions, especially adding fractions. On the surface, learners seem to forget the process – it has something to do with butterflies – or get confused with multiplication of fractions. There is sometimes weak understanding of the magnitude of fractions, wrongly expressing numerators and denominators as individual whole numbers, creating errors such as ½ + 1/3 = 2/5, or 1/3 > ½ because 3 is the bigger number. Sometimes (often), there is a rote reliance of procedure, with little conceptual understanding, leaving the learner open to errors.

Learners also need to have a sound knowledge of factors and multiples, primes, and the ability to conceptualise/visualise dividing things into smaller parts. All of these areas can be a sticking point, and yet they seem so foundational that we can assume that knowledge is secure.

An approach that follows the CPA model that I have used with both secondary and FE learners uses swimming pool 'noodles' cut to size. I admit that cutting to size is not a strength of mine, but learners do seem to find the noodles to be age appropriate.

By using the noodles, I can back track with precision teaching to pre-requisite knowledge. For example, Figure one shows the 'fraction family' starting with one half. This helps learners to develop a concept of the relationship between these fractions. I like to stress the role of prime numbers in determining these 'fraction families', halves, thirds, fifths, sevenths, and therefore the value of knowing prime numbers in helping us simplify fractions – or anything else that needs simplifying. I heart primes!

Fig. 1. Swimming pool noodle fractions. Alongside fraction families, it is essential to work with equivalent fractions from different families so that learners develop the relationship with factors and multiples.

Fig 2. Not 1!

I start off with a shape that is not one.

I have shown this to learners asking, “what is this?”, and elicited the response “x”. It is indeed an unknown, and the next task is for the learners to find the most efficient way of working out what ‘not 1’ equals, what is the smallest number of fraction shapes we can use? In my experience learners seem to start with one half and work from there.

Fig. 3. How big is not 1?

Once we have an idea of how big ‘not 1’ is, we can begin a discussion about the usefulness of our answer. What can we do to come up with an answer that is as economical as possible, that really tells us what our ‘not 1’ is in the symbolic language of fractions that we normally use?

As always, discussions are important here, and misconceptions. I find that the root of misconceptions

often comes out in these discussions allowing them to be addressed quickly. We can look at these and see that 2/5ths is not a reasonable answer, and that we need pieces smaller than the ones we have to give an answer with a single denominator. We can therefore assume that our new fraction will have more than two numerators.

Fig. 4. Our answer – it helps to track back to our equivalent fractions if scaffolding is needed.

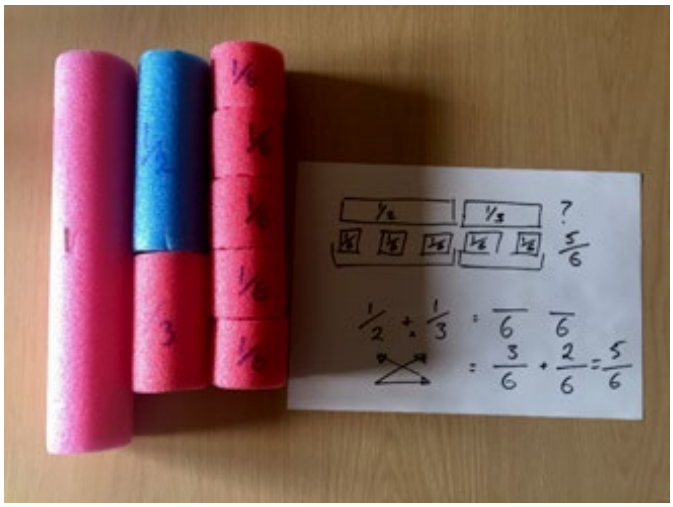


Fig. 5. Concrete and pictorial representations of fraction addition.

To gain our answer our learners have worked with a lot of arithmetic concepts but have always been able to visualise the arithmetic in a concrete form. Which is great, but there needs to be some way of connecting this visualisation into an efficient abstract form.

It is when we begin the move towards the abstract that we start to see the depth of conceptual knowledge that is needed.

So far, we have seen that ½ + 1/3 is the same as 5/6. What can we use to begin scaffolding a more generalised view? We now have the meaning of the denominator visualised, and the relationship between smaller and larger parts and the effect this can have on the numerator. But we can't use trial and error and a tangible representation all the time. We need to find a symbolic process to make our work more efficient.

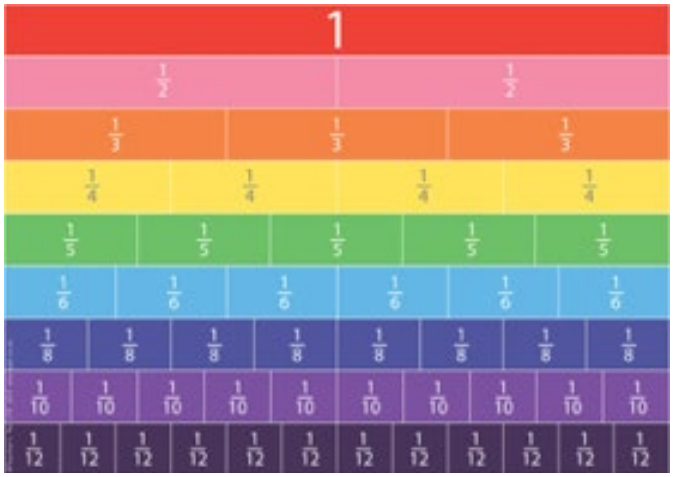


Fig. 6. Fraction mats help to visualise the relationships between different fractions.

Fraction mats help to work towards this abstract process. Learners also need a firm grip on factors and multiples as this will help them greatly. Seeing

or knowing that twelve has the factors of 2, 3, 4, and 6, but not 5, 8 and 10 is helpful and not knowledge that should be assumed. It is this knowledge of factors that helps greatly in the process of adding fractions.

The next step is to work with numerators larger than one. Say, ½ + 2/5. Knowing the relationship between 2 and 5 as denominators we can ascertain that we will need to work in tenths, 2 x 5. If we line these up on the fraction mat, we can see that 9/10 is equal to our ½ + 2/5. Our half is equal to 5/10 and 1/5 is equal to 2/10, so 2/5 is equal to 4/10. Our knowledge of equivalent fractions is essential here.

We are beginning to find a set of rules drawn from our tangible representations that can help us to understand the abstract process:

- If we add two fractions together we need to find a denominator that is a multiple of both the denominators we are adding. This new denominator will fit exactly into our two original fractions. This piece is smaller than the two pieces we are adding, and we will need more than two of these pieces. We need quite a lot of the smaller pieces to get the answer to what fits in our larger pieces.

- We can count how many smaller pieces fit into the larger pieces to get an equivalent fraction. We can count all our smaller pieces to find our answer. We can use multiplication to count in groups as this is quicker.

So now, when confronted with 2/5 + 3/7 we can work out that our new denominator will be 35. 1/5 is 7/35, and 1/7 is 5/35. Learners with flexibility with numbers will start to see patterns emerging without resorting back to a pictorial representation, others will need scaffolding until they feel secure. Where scaffolding is needed there is a clear route back and areas of weak understanding or misconception can again be addressed.

Where scaffolding is needed there is a clear route back and areas of weak understanding or misconception can again be addressed.

The CPA method is highly versatile and can help to identify and remediate areas of insufficient knowledge quickly. In this way it is more efficient that re-explaining the abstract. Ideally, this approach is used for all teaching for all learners rather than a mechanism for catch-up, but it definitely has a place in the secondary classroom. The key lies in the journey from the concrete to the abstract and by recognising where the sticking points lie.

Fyfe, E. McNeil, N. Son, J.Y. and Goldstone, R (2014) Concreteness Fading in Mathematics and Science Instruction: A systematic review. Education Psychology Review. Vol. 26:9-25. Doi: 10.1007/s10648-014-9249-3

NCETM (Online) Levels in the Learning of mathematics. Accessible from: https://www.ncetm.org.uk/public/files/192602/Levels%20in%20the%20learning%20of%20maths%2019.doc retrieved 25/5/2018

A day in the life of a hospital teacher by Jane E

By popular demand **Jane** is back to recount her further adventures in a hospital school somewhere in the North of England.

I did agree to describe an average day in our hospital school but I am struggling to recall 'an average day', so I am going to amalgamate a day that is as representational as it can possibly be and give you a background to the role. Here goes.

We work very closely with the medical teams on all of the paediatric wards; the young people that appear on our register are 'handed over' by the ward medical staff every morning, to our teaching assistants (TA's), when they get the morning updates from the wards. This happens every morning. The young peoples' names are taken and recorded then after three or more days of being in hospital an information passport is completed by a member of our school staff - this is usually done by the ward teacher. Consent is taken from their parent or carer for them to embark upon lessons. This process is unfortunately rarely straightforward because usually the last thing on any parent/carer's mind when their child is unwell is school so therefore a level of diplomacy and empathy is required when collecting the relevant information.

Picture if you will, the delight on the faces of the young people when a teacher arrives in their room wanting them to engage in education…Needless to say, I have developed a thick skin and the enthusiasm of a CBeebies presenter in order to combat this initial resistance. Like a salesman on commission my persistence is generally rewarded and lessons in hospital soon become a welcome break in the family and young person's day. I never cease to be in awe of the tenacity and determination that most of the young people display when they do finally participate in lessons; they achieve exceptional work in exceptional circumstances.

After the completion of a passport the young people are effectively dual registered; our administrator enters the data on to an e-pupil record and contacts the home school, sending a generic email. It is often necessary to follow up on this generic email and contact the young person's home school head of year or class teacher to request more detailed information and/or current subject information so that a personalised scheme of work can be delivered. The rationale behind this is so that the young person can continue with their home schoolwork, keeping them up to date with their curriculum while ensuring that they have no significant gaps in their learning.

Picture if you will, the delight on the faces of the young people when a teacher arrives in their room wanting them to engage in education

Remember how much we all love data? Well, this is the front line and the information that is collected on the wards, usually bedside, is integral to how the teaching and learning is delivered. If the passport is completed with the correct and relevant information

a teacher should be able to pen a brief case study of the young person and provide the up to date information required to commence lessons.

Lessons last for 30 - 40 minutes and we deliver a lesson to each young person in the morning and one in the afternoon, (the legal minimum requirement for education is an hour a day), we are allowed on the wards between 9.30 am and 12 noon then 1.00 pm until 3.15 pm. Frequently, it feels like there are not enough hours in the day to teach all of the young people in our care not to mention contact home schoolteachers, social workers, health care professionals or parents which is why the planning from home schools is incredibly important and greatly appreciated.

At the start of our day we have a morning hand-over meeting commencing 8.40 am and finishing at 9 am. We then have 30 minutes to plan the days' lessons. This is when a hospital teacher transforms in to a key stage and subject chameleon. Allow me to expand up on this analogy.

I am the ward teacher for four wards; I share in the delivery of education on ward 3, which is a specialised ward, it is the Bone Marrow Transplant ward (BMT). Due to the demands of delivering a lesson on the BMT ward each teacher is assigned one pupil because the young people on the BMT ward have their lessons in an hour slot. All staff that come into contact with the BMT pupils are required to scrub and gown up in order to enter their contained rooms. All the resources for the BMT pupils need to be sterile when they are taken in or out of the young person's room. This often presents a challenge when you are trying to keep lessons fun and engaging - young people can be isolated in their rooms often up to 3 months at a time - these lessons require extra care and attention to detail when they are being planned for. A high proportion of our young people on the BMT have English as an additional language (EAL) and they require a personalised and bespoke curriculum, which their teacher is responsible for.

On any of my wards at any given time I can have young people whose ages and abilities range from reception to year 11, I plan and deliver lessons for each of them because their lessons are usually on the wards, in their rooms, one to one. Often parents/carers and medical staff are in the rooms when their lessons are taking place so this is not a job for the self-conscious. Consequently, this high ratio of adults to young people often presents as a barrier to learning and requires a great deal of skill to ensure that the young person is on task and focussed in order for them to fulfil their learning potential; this is probably one of the role's greatest challenges, delivering lessons with a host of distractions unfolding around you.

the environment is that of a 'normal' school classroom and it provides the young person with focussed educational time

We work very hard to try and facilitate lessons in our classroom and it is fantastic when a young person can work in the classroom because the environment is that of a 'normal' school classroom and it provides the young person with focussed educational time. I currently have a year 2 pupil

who is post-BMT coming to the classroom every day while he is receiving treatments on the day unit; he is staying with his family in the halfway house and his lessons are an important part of his day. Since he has been able to come to the classroom he is making great progress – obviously this progress goes hand in hand with his physical recovery. This is a truly rewarding experience when you are part of a young person's recovery process.

We are a small team but we have subject specialists among the team who can deliver their particular subject when a young person requires their skills and knowledge so even though our teachers have their own wards, that they are responsible for, there is flexibility within the teaching day to ensure the best outcomes for the young people in hospital.

The role of a hospital teacher is incredibly varied – In one day I can deliver a lesson on the theme of kingship in 'Macbeth' to a year 10 pupil receiving kidney dialysis the next lesson could be introducing decimals on a number line to a year 3 pupil who is recovering from a surgical procedure but this is exactly why I enjoy my job so much.

Like all teachers we have to adhere to assessment and quality assurance processes, we are still OFSTED inspected and have performance management targets like every other education professional but instead of delivering lessons to a class of thirty young people we work in a medical environment. Finally, I could not give an insight in to the role of a hospital teacher without mentioning the emotional challenges that are inevitable when working with sick young people. There is nothing that can prepare you for a young person losing their fight for life and it does affect you but it is a privilege to work with these young people.

Shanghai Maths

In this article Mark Pepper explores a phrase that is very commonly used in all areas of England. Do you agree with him? What are your views on Shanghai Maths?

There appears to be a consensus among the policy makers of maths education in this country that there should be a wholesale adoption of Shanghai Maths in our classrooms. This view is likely to have been influenced by the results of Pisa and Timms international league tables in which the UK has achieved low rankings in comparison to countries within the Pacific Rim. In the foregoing references to maths, China (including Shanghai) and Singapore will be used interchangeably but will generally be referred to as Shanghai Maths.

What is Shanghai Maths?

A term in common usage with reference to Shanghai Maths is Maths Mastery. A succinct definition of it

is supplied by Neha Bagri (2017):

"The method dubbed the "mastery" approach entails a collective approach to learning where the entire classroom learns a single mathematical concept in depth, relying on standardised textbooks. The class does not move on until every student has understood the concept."

With reference to the methods of presentation of lessons there are widely divergent approaches. This can be illustrated by the contrast between two articles from different writers who describe their first hand observations of a maths lesson in Shanghai classrooms. Both articles were published in *Mathematics Teaching* within a period of four months of each other.

Shane Walsh (Nov 2015) reports:

"Of the lessons we saw, teaching was not as such a shared learning experience but rather the transmission of knowledge from the teacher to the students; teaching was more about the passing on of knowledge than enabling understanding…The dominant role of the teacher," the one size fits all" lessons with a lack of additional materials to support and to stretch and the passive role of the students as "recipients of information" made it difficult to gauge the level of students' understanding."

Mike Askew (Nov 2015) describes a lesson that he observed and stresses that the children worked with much autonomy in:

"…the degree of choice…over the method they used. This was not a "one-size-for-all" lesson"
He also stressed that meticulous care had been taken in the provision of specially constructed concrete materials to support the learning.

Helen Warrell (2017) also describes Shanghai Maths as a means of encouraging the pupils to consider different calculation strategies. She quotes Ben Har of Singapore's Institute of Education:

"If the teacher is just "telling" them everything, the pupils become passive and they develop the mindset that learning maths is a set thing…But now they are seeing that learning maths is challenging other people's ideas, or agreeing with them if they are correct."

But now they are seeing that learning maths is challenging other people's ideas, or agreeing with them if they are correct.

The contrast between the teaching strategies outlined above could scarcely be more stark. This suggests that there are a range of different teaching approaches within Shanghai classrooms with some teachers favouring a traditional approach whilst others employ more progressive methods. This is made possible due to the high level of autonomy that exists for Shanghai teachers. This is reminiscent of the system that prevailed in the U.K. in the 1970s when there was a dichotomy between teachers who favoured a traditional approach and those who chose to use progressive methods.

The methods of Mastery used by teachers who use a traditional approach can extend to the physical organisation of the classroom.

Sally Weale (2015) describes the approach that was used by Chinese teachers who taught maths in an English secondary school. This included rearranging the classroom into a formal setting:
"The classroom has been reconfigured to resemble a Shanghai classroom…desks which are normally clustered in friendly groups are in straight rows and all eyes are on (the teacher)."

She also quotes one of the English teachers:

"There is a lot of chanting and recitation which to our English ears seems a bit formulaic."

Resources to support the teaching of Shanghai Maths

Textbooks

The resources that are to be made available to assist in the implementation of Shanghai Maths consist of textbooks and on-line materials. A question that arises is which textbooks should be selected. A second question to be considered is whether these textbooks should be centrally imposed on schools. There have been suggestions that textbooks of Singaporean origin should be made a mandatory component of maths teaching in primary schools, Oates (2014). Mertens (2015) and a number of other critics have strongly opposed this proposal. Nevertheless it seems probable that the statutory implementation of textbooks will be imposed. Bagri (2017) reports that:

"Following a deal signed between Harper Collins and the Shanghai Century Publishing Group, textbooks used to teach mathematics in Chinese primary schools will be translated for use in Britain."

It is to be hoped that great caution will be taken in the selection of textbooks emanating from Singapore. *Math in Focus: the Singapore Approach* was recently used as a key maths teaching resource in a prominent chain of academies. Close analysis of the content of the books reveal a great many errors (Pepper 2014). One of the difficulties arose from the fact that the material was specifically designed for use in American schools. Hence the vast majority of references to measurement are within the imperial system. Within the relatively few examples of metric measurement there are exercises that consist of illustrations of objects accompanied by a label intended to represent the measurement of the object. Many of these give totally unrealistic readings. Examples of these include the length of three small beads and three larger beads being labelled as 3 metres and the mass of three tomatoes is shown to be 10 kilograms! There are many other examples of gross errors and inaccuracies throughout the books.

There are many other examples of gross errors and inaccuracies throughout the books.

On-Line Resources

The on-line resource applicable to the implementation of Maths Mastery is located on the N.C.E.T.M. website which is unsurprisingly entitled Maths Mastery. One of the main strengths of this resource is that most of the exercises involve the

application of skills learnt and in some instances require the use of logical reasoning.

As already mentioned, an inflexible rule applied to Maths Mastery is that every individual pupil must show understanding of a concept before the class collectively move on to a new concept. If this approach was to be rigidly applied within Maths Mastery lessons in U.K. schools, great difficulties would be encountered due to the wide range of abilities in most classes. The authors of Maths Mastery, possibly in anticipation of this difficulty, give the following assurance in a subsection entitled *A mastery curriculum*:

"There is no such thing as "special needs mathematics" or "gifted and talented mathematics".

There is plenty of evidence to refute this extraordinary claim as can be found by visiting any S.L.D. classroom or by working with pupils with learning difficulties within a mainstream school. Many classrooms in the U.K. contain pupils with a wide range of ability and commonly include pupils with learning difficulties. It would be a totally unworkable policy to repeatedly work collectively at a single concept in the hope that eventually every child would understand it. This process would produce acute embarrassment for the individual or small group deemed to be holding up the class. This policy would also produce difficulties for the higher achievers as the teacher could only provide a certain amount of extension materials before the onset of acute boredom for the most able pupils.

Assessment

The KS.2 National Curriculum Tests (NCTs) of recent years complement the teaching and learning of Shanghai Maths. This is embodied in the fact that within Shanghai Maths a single concept is taught to the entire class. The Arithmetic Paper of recent NCTs has involved a marked increase in the number of questions involving long multiplication and long division. Furthermore both within the advice to candidates and in the marking scheme it is stated that an additional mark may be awarded if the "formal method" is used and no more than one mistake is made. This acts as an incentive for teachers to teach one method of calculation to the exclusion of alternative calculation strategies (Pepper 2018). Hence the teaching of a single algorithm in accordance with Shanghai Maths methods can lead to extra marks being awarded in the Tests. The fact that the most recent NCTs have become more formal is also apparent in that calculators are now prohibited from use in all of the papers and the mental maths paper has been abolished.

"There is no such thing as "special needs mathematics" or "gifted and talented mathematics".

There is also evidence that KS.2 teachers are being encouraged to "teach to the test". At a recent seminar entitled High Stakes Testing in Mathematics it was overtly recommended that teachers should study the content of past N.T. papers in order to establish which themes occurred most frequently and then use this information to inform the content of their lessons.

Cultural Differences

The differences in culture between Shanghai and the U.K. have a strong influence on the respective education systems of the two countries. David Reynolds (2015) reports that:

"A key difference … is that students in Shanghai get homework every day, with a test every week. (In England pupils can expect maths homework once or twice a week)".

John Jerrim (2015) echoes this view by stating that Shanghai's success is largely due to factors:

"…ranging from culture, to private tutoring and parental investment."

Conditions of Service of Teachers in China and in the U.K.

There are significant differences in the conditions of service for teachers in Shanghai and in the U.K. Shane Walsh (2015) describes the vast difference in the training provided within the two countries:

"… significant time and emphasis was placed on in-service training in schools…In the first 5 years of a Shanghai teacher's career, they will have undertaken 360 hours of professional development."

Helen Warrell (2017) makes a comparison between the degree of autonomy enjoyed by teachers in Singapore compared to U.K. teachers:

"One of the hallmarks of the Singaporean system is high levels of autonomy for individual teachers, who are given far more time than their U.K. peers to plan lessons".

Bagri (2017) makes the significant point that whilst in Shanghai teachers in the primary sector are trained to exclusively teach maths, U.K. primary teachers are trained to teach a wide range of different subjects.

Conclusion

Due to the superior position in international league tables of the Pacific Rim countries in comparison to the U.K. it is unsurprising that a common interpretation of this is that Shanghai Maths is a more efficient method of teaching than that currently in force in the U.K. If the conditions of service of teachers and the national culture of these countries were similar then this would be a credible assessment. In reality, as already discussed, teachers in Shanghai have significantly more none-contact time, in service training and autonomy than their U.K. counterparts. Hence it can be concluded that the proposition that Shanghai methods are superior to those of the U.K. is unproven.

There are significant differences in the conditions of service for teachers in Shanghai and in the U.K.

The consequence of the fact that a central tenet of Maths Mastery is that within a single lesson only one mathematical concept will be taught is that the breadth of subject matter will be constrained.

Whilst in the more progressive classes the pupils would be encouraged to develop their own calculation strategies there would be no scope for more general problem solving that fall outside the domain of the concept being studied. In the more traditional classrooms a single concept would be studied and the pupils would be expected to passively listen to the teacher and then reproduce the method of calculation that they had been taught. The requirement that the class does not progress to a new concept until there is understanding by the whole class would almost certainly prove to be unworkable within the current U.K. system. If this were to be introduced then the current system of an element of mixed ability classes as well as a policy of inclusion would be placed in jeopardy. There would also be no point in continuing with individual teaching plans as the whole class would be working at the same concept.

pupils would become more efficient in the reproduction of number facts and in the application of taught algorithms

One positive aspect of the use of Shanghai Maths in U.K. schools is likely to be that pupils would become more efficient in the reproduction of number facts and in the application of taught algorithms. A probable disadvantage would be that pupils would not become proficient in developing creative ideas to solve problems or to apply skills learned to problems encountered within a variety of different contexts.

References

Askew, M *A little Knowledge…*

Mathematics Teaching Issue249 Nov 2015

Baghri, N More children in the west are being taught math using China's fabled, slightly brutal "Mastery Method".

W.W.W 24 March 2017

High stakes testing in mathematics

Seminar at UCL London 5 December 2017

Mertens, R Why are we blindly following the Chinese approach to teaching maths

The Guardian 10 February 2015

NCETM web-site A mastery curriculum

Oates, T Why textbooks count

Cambridge Assessment November 2014

Pepper, M Math in focus: The Singapore Approach

Mathematics Teaching Issue 239 March 2014

Pepper, M KS2 Mathematics Curriculum National Tests One step forward or five steps back

Primary Mathematics Vol 22 Issue 1 Spring 2018

Warrell H Schools take leaf out of Singaporean maths book

Financial Times 21/22 October 2017

Walsh, S The Shanghai Secret?

Mathematics Teaching Issue 245 March 2015

Weale, S Shanghai teaching methods "could improve UK results within four years". Quotes John Jerrim and David Reynolds

The Guardian 26 November 2015

Weale, S Chinese teachers bring the art of maths to English schools

The Guardian 13 March 2015

Mark Pepper

Primary maths resources – economy class

Mark Pepper **provides an overview of the, economical, resources he has found most useful from his many years of teaching, latterly with pupils with visual impairment.**

A consequence of education cuts is that maths departments are obliged to operate within tight financial limits. Whilst these cuts can be continuously opposed, teachers need to get the maximum value from the resources that are made available to them.

All of the suggested resources can be produced with a minimal amount of labour.

The word "economy" contained in the title predominantly involves economy of cost but additionally it encompasses economy of time. All of the suggested resources can be produced with a minimal amount of labour. It should be emphasised that these resources should be considered as ***supplements*** to the essential mathematical resources that are required for classroom teaching.

A secondary purpose of this article is to question whether some of the existing mainstream resources are in fact effective - and if not, whether the money spent on them could be used more usefully on alternative resources.

AT 2 Number and Algebra

The Counting Stick

The counting stick was introduced at the launch of the National Numeracy Project in 1999 and featured in one of the training videos in which the use of it with a primary class was impressively demonstrated by a teacher named Roger Bird. Both the teaching skill of Roger and the total captivation of the class are clearly demonstrated. This clip can be viewed on-line on Vimeo.

The counting stick consists of a metre rule that is sub-divided into ten equal sections of two alternating colours. The versatility of its use is demonstrated through activities that reinforce concepts associated with the ordering of numbers, odd and even numbers, doubling and halving and the learning of factors and multiples. It is particularly helpful as a means of learning multiplication tables as a fun activity.

The Empty Number-Line

The empty number-line (EML) should be used as a supplement to the essential resource of a classroom number-line and individual desk top number lines for each member of the class. The EML provides a useful means for pupils to make their own calculations such as using appropriate jumps to find multiples of a number and for convenient methods of addition and subtraction.

Class Calendar

A calendar that contains colourful illustrations can

be used as a resource to stimulate mathematical discussion in a natural way. It should be based on a theme that is of interest to as many members of the class as possible and placed at a focal point of the classroom. Beneath each date there should be several lines to enable hand written entries to be made. The class could then be encouraged to make suggestions regarding entries that could be written beneath particular dates. These could include the birthdays of each member of the class, term dates and specific events such as sports day, the Christmas play and class visits. Questions can then be posed such as:

How many weeks ago did we last perform a class assembly?

How many days till our trip to Lords Cricket Ground?

Coins

It is helpful to use real coins as opposed to plastic imitations. This helps to reinforce the concept that mathematical resources are directly related to real life experiences. Discussion and questions can then be posed related to the calculation of costs and the change that should be given. An activity that involves estimation and problem solving concerns the date of a particular coin. The teacher holds up a coin and asks the class to consider how old it appears to be. After various responses the teacher then asks for a method to calculate the age of the coin. Eventually it will be agreed that this can be achieved by subtracting the date on the coin from the current year. This can be done individually and then the answer can be checked with the use of a calculator.

Sum things

Sum things consist of a string of ten coloured beans. They are a helpful resource for counting activities and the learning of number bonds up to 10. The particular strength of this resource is that when the string is held upright the beads do not descend to the bottom of the string. Each bead can be moved individually and it will then remain in a fixed position. This means that in an operation such as 6+2, the learner can count 6 beads and move them to the bottom of the string. A further 2 beads can then be pulled down to join the 6 beads. The learner can then count all of the beads on the string to give a total of 8. This resource is particularly helpful for pupils with poor fine motor skills as the manipulation of sum things is much easier that the use of a resource such as multilink cubes. They can be ordered from St Joseph's Workshop in Manchester.

This resource is particularly helpful for pupils with poor fine motor skills

Board Games

The resources required for in-house produced board games are of minimal cost as all that is needed is an A3 copy of the game which would then be laminated, counters and dice. The games could include the Cat and Mouse game and the BMX game (Pepper 2017).

AT 3 Shape, Space and Measure

There is little alternative to ordering conventional resources within this AT. Hence measuring equipment, sets of 2D shape and construction material would all need to be ordered from commercial sources. The exception to this involves 3D shape. It is unnecessary to obtain a standard set

of 3D shapes as this can be created with the use of junk materials. Examples of this could include a smartie tube to represent a cylinder and a tea packet to represent a cuboid.

AT 4 Data Handling

Resources related to this AT can be obtained for minimal cost. Materials should include squared paper for the creation of various types of graph. Most of the other activities such as the collection of data and the production of tally charts only require paper and writing materials.

On-Line Resources

Two excellent BBC websites, *Bitesize* and *Skillswise*, are free of charge. They cater for the teaching of English and mathematics, though only the maths content will be considered here. Whilst *Bitesize* is normally intended for the primary sector and *Skillswise* is recommended for use within the adult sector, both sites can be used interchangeably between both sectors. As most primary teachers are likely to be familiar with the benefits of the use of *Bitesize* it is probable that they would be less familiar with *Skillswise*.

This resource is relevant to the primary sector as the material provided is exclusively within the range of levels of E1-L2. Thus it is implicitly aimed at lower achievers within the adult sector. Within my own teaching experience I have made extensive use of *Skillswise* both when teaching at a college of further education *and* within teaching in primary and secondary schools.

Breadth of materials

The content within the *Skillswise* site comprehensively covers all of the main components of the mathematics National Curriculum as is evidenced by the inclusion of the following sections: Number, calculation, percentage and fractions, measuring, shapes and graphs.

Each of these sections is then subdivided into specific topics.

e.g. Number is subdivided into number lines, number symbols, place value, decimals, negative numbers, rounding and estimating and formulae. A click on one of these categories will produce two headings of *Quiz* and *Videos* with a choice of levels Entry 1 and 2, Entry 3 and Level 1.

Fact sheets and worksheets

The fact sheets effectively convey the information in a concise manner and they are particularly helpful within a revision context.

the production of tally charts only require paper and writing materials

The worksheets provide exercises and activities directly related to a specific fact sheet.

A worksheet that I have found to be particularly useful is contained in the *Imperial Metric* section which is located within the measurement component. This consists of a crossword in which the clues involve metric and imperial measurement. This consistently generated considerable interest for the students that I have taught. Another worksheet that was both effective and generated considerable interest consisted of a table comprising several

columns, some of which were blank. The learners were required to complete the columns concerning the selection of an appropriate measurement instrument and an estimate of the weight or size of an everyday object. I cannot now locate this worksheet on the website and can only assume that it has been withdrawn, which is highly regrettable.

Resources of Questionable Value

The converse of obtaining resources at a minimal cost is to invest in material of doubtful efficiency. An example of this is Cuisenaire Rods.

Cuisenaire Rods

This resource was introduced in the New Maths era in the 70s. It was then felt that the use of resources such as Dienes M.A.B. and Cuisenaire Rods would enhance the underlying concept of number of the pupils. Whilst Dienes M.A.B. are not evident in today's classrooms except in some instances in which Base 10 material has been retained, Cuisenaire Rods appear to be flourishing. They are widely commercially available and some organisations such as the Association of Teachers of Mathematics have strongly endorsed their use. This popularity is perhaps surprising. One of the disadvantages is that the pupils are required to learn facts, such as the value of each colour, that are redundant beyond the direct use of the rods. Martin Hughes (1986) conducted research based on direct observation of pupils' use of the rods in the classroom. He describes a case in which a boy correctly added two numbers with ease with the use of formal methods. He then got into difficulties as he tried to make it appear that he had obtained his answer though use of the rods. His motive for this was to "please his teacher."

Kath Hart (1989) describes the difficulty many children have in "… moving from the concrete or pictorial representations to the more formal (general) aspects of mathematics and the inability to link these stages of the learning process".

Conclusion

The use of some of the resources that have been suggested here have an additional benefit beyond economy of price and time. Use of these materials reinforce the notion that there is a close relationship between the learning of mathematics and interaction with the environment outside of a school setting. This helps to counter an interpretation of mathematics as being a discreet subject that depends upon the use of specialised resources that are exclusively encountered in the classroom.

there is a close relationship between the learning of mathematics and interaction with the environment outside of a school setting

References

Hughes M (1986) *Children and Number: Difficulties in Learning Mathematics* Wiley Blackwell

Hart K (2004) *Children's Understanding of Mathematics* Eastbourne Antony Rowe Publishing Services

Pepper M (2017) *Fun Activities from Struggle to Equals to Equals On-Line* in Equals Vol 22 No 2 Summer 2017

The percentage dice game

Sue Knox got in touch to share a simple but effective dice game to help students become familiar with, and practice, calculating percentages of amounts.

This is a simple but effective game that helps students become familiar with calculating percentages of amounts.

You will need either 2 blank dice (which you can buy online) or small round stickers that you can use to customise normal dice.

One dice will have amounts on it (a different amount on each of the six sides) and the other dice will have percentages.

Here is an example of numbers to use:

1st dice:	16,	20,	80,	120,	200,	400
2nd dice:	0%,	10%,	25%,	50%,	75%,	100%

The game:

Each player rolls both dice and calculates their score (e.g. if 120 and 50% are rolled the score is 60).

Players take turns keeping a note of their running total.

Whoever reaches a pre-agreed target first is the winner (e.g. 500, 1000).

The game can be adapted for different levels by using less common percentages, including decimal answers and/or not allowing calculators.

Sue often uses this with lower ability students and suggest that:

- You will need to customise 2 dice by writing amounts on one and percentages on the other.
- I usually play this game with low ability students after teaching them a fail-safe calculator method for working out percentages of amounts.
- It also helps to reinforce that 0% of a number is nothing and 100% of a number is all of it.
- The students usually start off by calculating their score using the calculator method. I will calculate my score using mental methods (eg I know 25% is a quarter and I can find a quarter of a number by halving it and halving it again). After a few rounds the students are normally starting to use the mental methods and becoming very familiar with percentages.

Why not give measuring a try?

In this article Alan Edmiston shares a resource, that explores the measurement system, for you to try with your own pupils. He has used this with learners from 7 to 13 with surprising results.

These days I find myself agreeing more and more with T. Nunes and P. Bryant who said in 'Children Doing Mathematics' that measuring:

"is clearly not a simple task and children do not master units of measurements just from recognising them on a ruler, for example, and knowing what they are called. They need to be involved in activities where their apparent simplicity is destroyed. We suggest that children are likely to profit from the need to measure in unusual circumstances, such as using a broken ruler or using rulers that are too short for their purpose, so that they have a measurement problem to solve and need to do more than read the value from a ruler."

In my view this book is a must read for all teachers who are serious about supporting their pupils in the mathematics classroom.

In my view this book is a must read for all teachers who are serious about supporting their pupils in the mathematics classroom. My work teaching a range of pupils and supporting their teachers to develop mathematical thinking (most often using the Let's Think Math's or the CAME resources) has further led me to reassess the role that a deeper understanding of the measurement system could play in supporting children's thinking. There are so many concepts involved in measuring such as:

- Zero,
- The notion of an even interval scale,
- Fractions and,
- Ratio,

that I now feel it is worth introducing pupils to the measurement system regularly throughout Years 1 and 2. So rather than take up too much space in this edition of *Equals* I feel the best thing I can do is to share a simple activity to start a wider debate on the foundational experiences necessary for healthy mathematical development. This activity is directly based upon the advice suggested by Nunes and Bryant above and so it allows us to tap into a rich vein of ideas that can be explored and developed within any classroom.

You can imagine the fun when they are told that no one has the correct length.

The resources included below, from a Let's Think Math's lesson called 'Broken Rulers', could be used as a couple of short challenges or expanded into a full lesson. I will provide brief prompts to enable you to explore the

activity and all I ask is that you please let us know the thoughts that are prompted by trying them and the responses of your pupils. Similarly if you want to know more then please get in touch. I have tried this activity with pupils up to Year 8, in a range of contexts.

Activity 1 – same line but different rulers
(sheets A and B)

Here the pupils are required to measure four lines, all the same length, with one of four rulers. A close inspection of the resource will highlight the problem: all begin with different numbers and some have missing or duplicate numbers. This part is a real joy - the majority of pupils simply read the last value, on their ruler, and say that the line is; 9, 10, 11 or 12 cm long. You can imagine the fun when they are told that no one has the correct length. Yes some may work out that the true length is 8cm but with such a range of answers the true value is lost in the genuine challenge this brings and the debate that follows when they are told they do not have the correct answer.

Activity 2 – good and bad rulers
(sheet D)

Here the pupils have to write a report on the faulty rulers a factory is producing. See resource below for the four they are required to comment upon. They love this and I often ask them to say something good about each ruler to get them to think about the need for the same gap when measuring.

Activity 3 – making their own ruler
(sheets E and F)

With such practice with measuring they are now experts and so can make their own rulers. Each pair of children is given two blank rulers to choose from: one that contains a gap from the edge of the ruler to the zero and a second with no gap. They now add on the numbers are use these to measure things within the class.

It is worth mentioning zero at this point, for it is not a common sense counting number, but without it we would be unable to measure accurately. Broken Rulers puts children in the place of having to 'invent' zero as a meaningful part of the measurement system. This was clearly illustrated to me when teaching just this activity to a Key Stage 4 group in a special school, Beacon Hill, in North Tyneside. All of the incidents mentioned above manifested themselves until about 20 minutes in when a Down Syndrome boy jumped up shouting; 'You have tricked us, there is no zero.' He then proceeded to point out all the rulers were wrong and that not one included a zero. With his help we were able to illustrate why zero is such a key part of the measurement system.

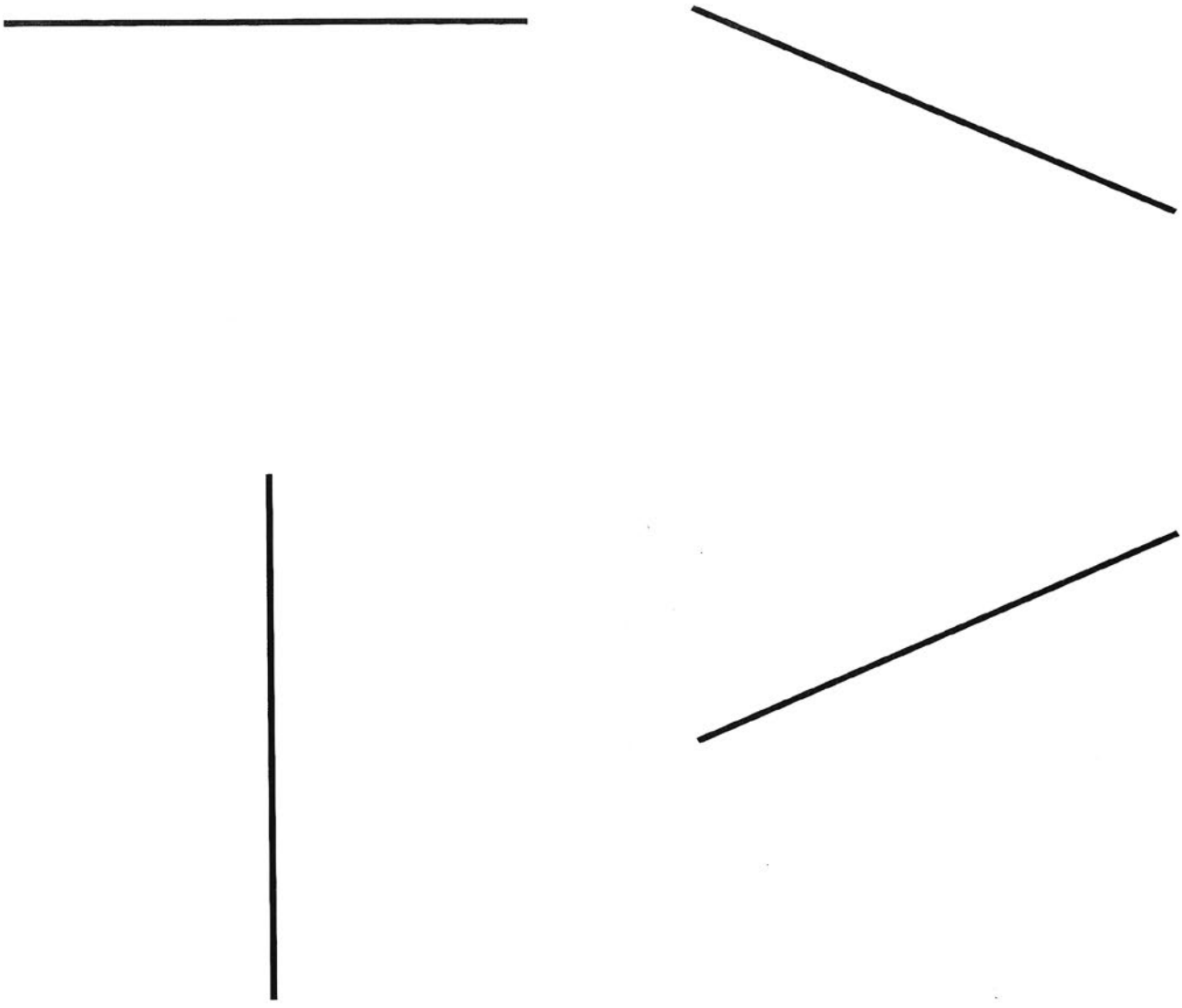
It is worth mentioning zero at this point, for it is not a common sense counting number, but without it we would be unable to measure accurately.

I strongly recommend that you try this activity for it will give you an insight into how your children are thinking and that in itself may be all you need to support them.

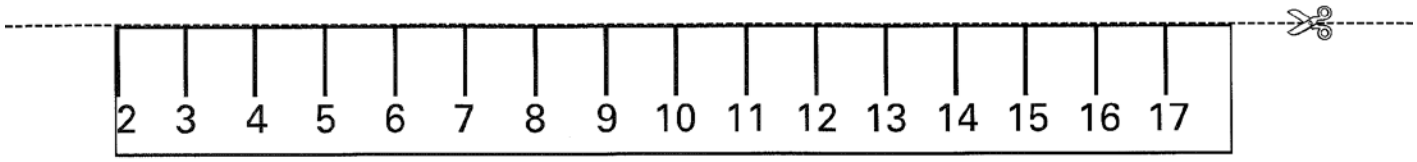
MEASUREMENT 2

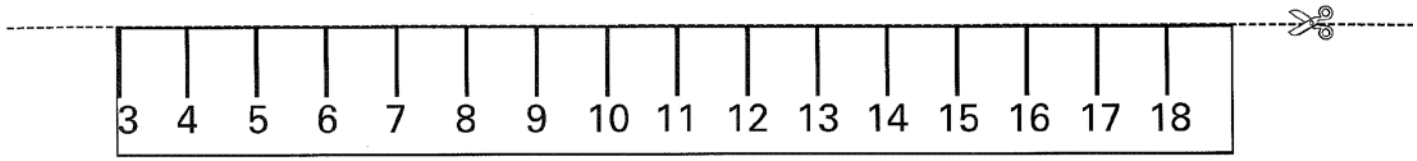
Broken Rulers

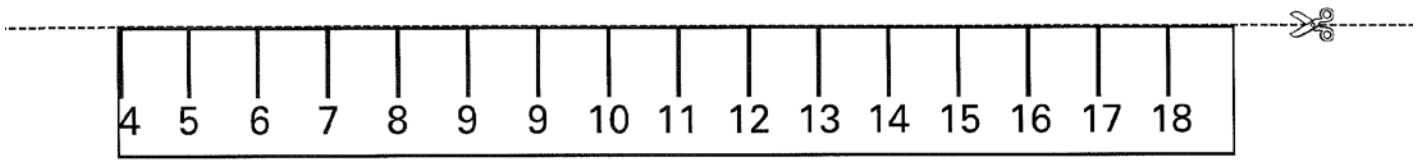
Resource Sheet A

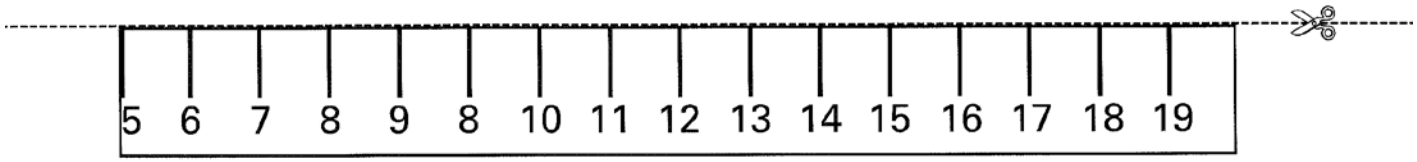


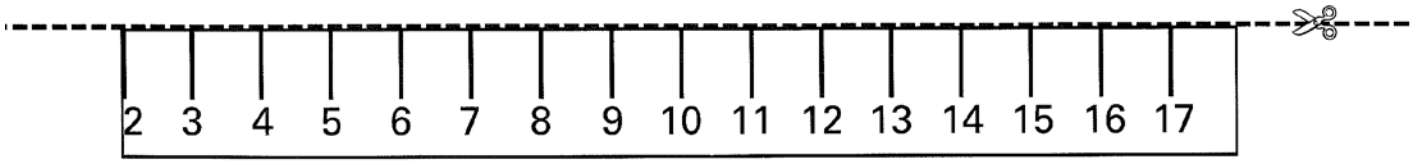
Broken Rulers
Resource Sheet B

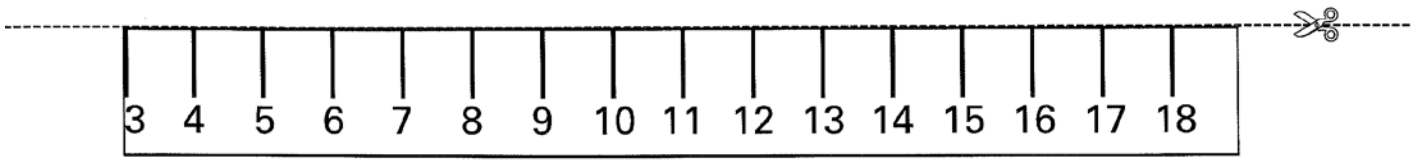


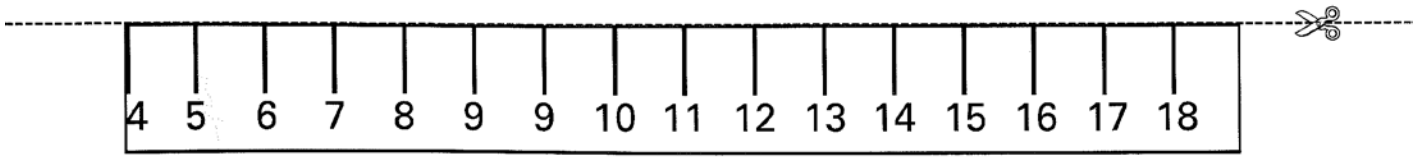


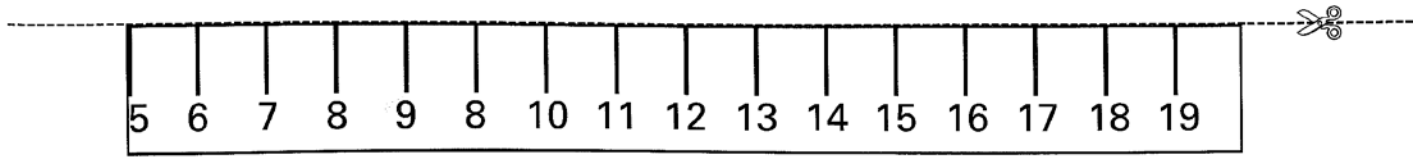




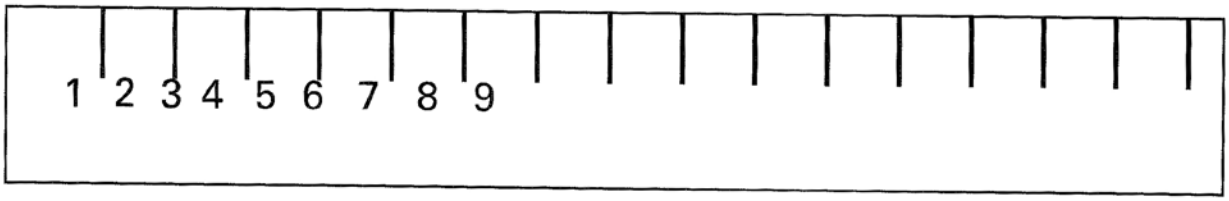


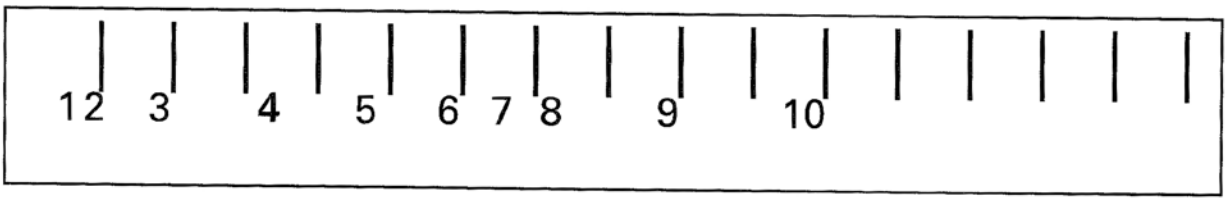


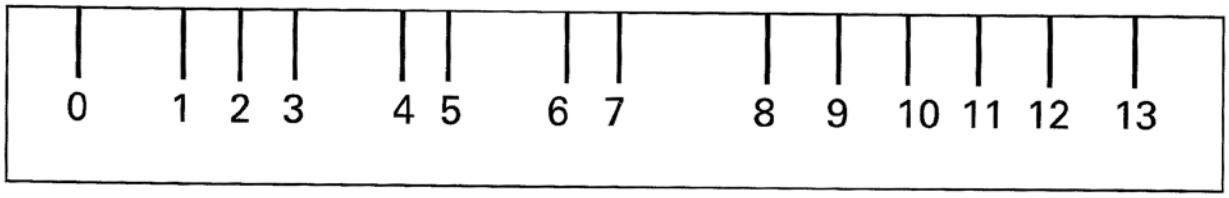


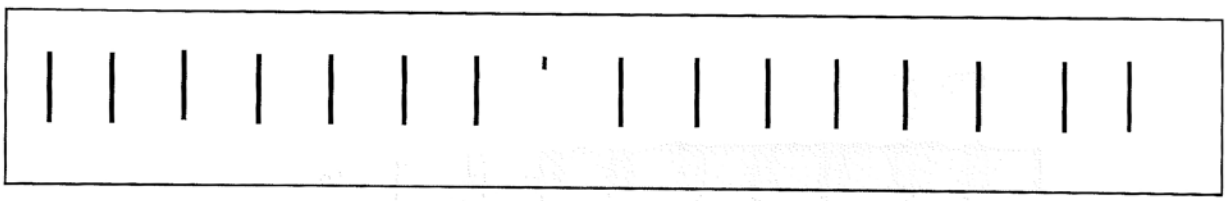


Broken Rulers
Resource Sheet D





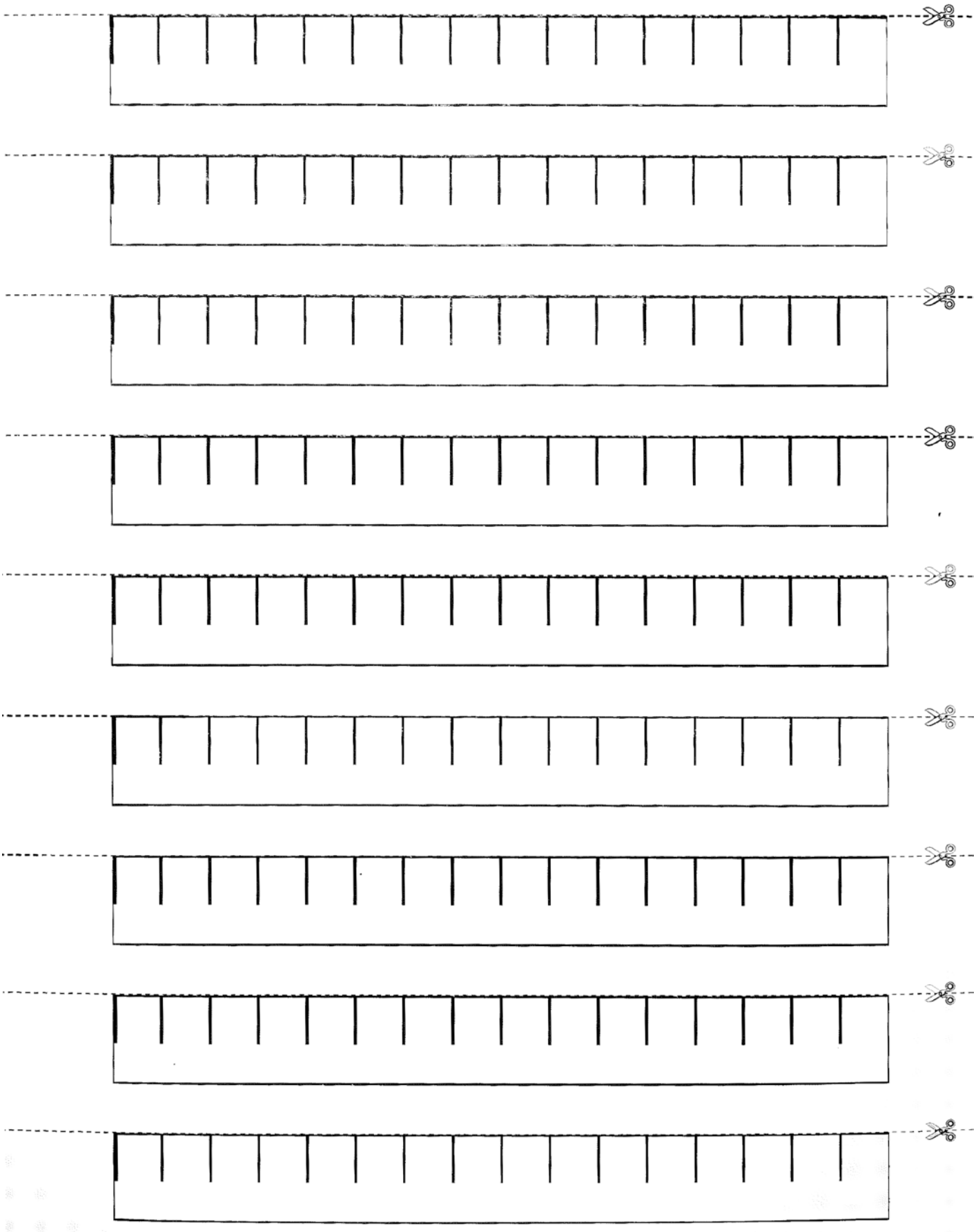




MEASUREMENT 2

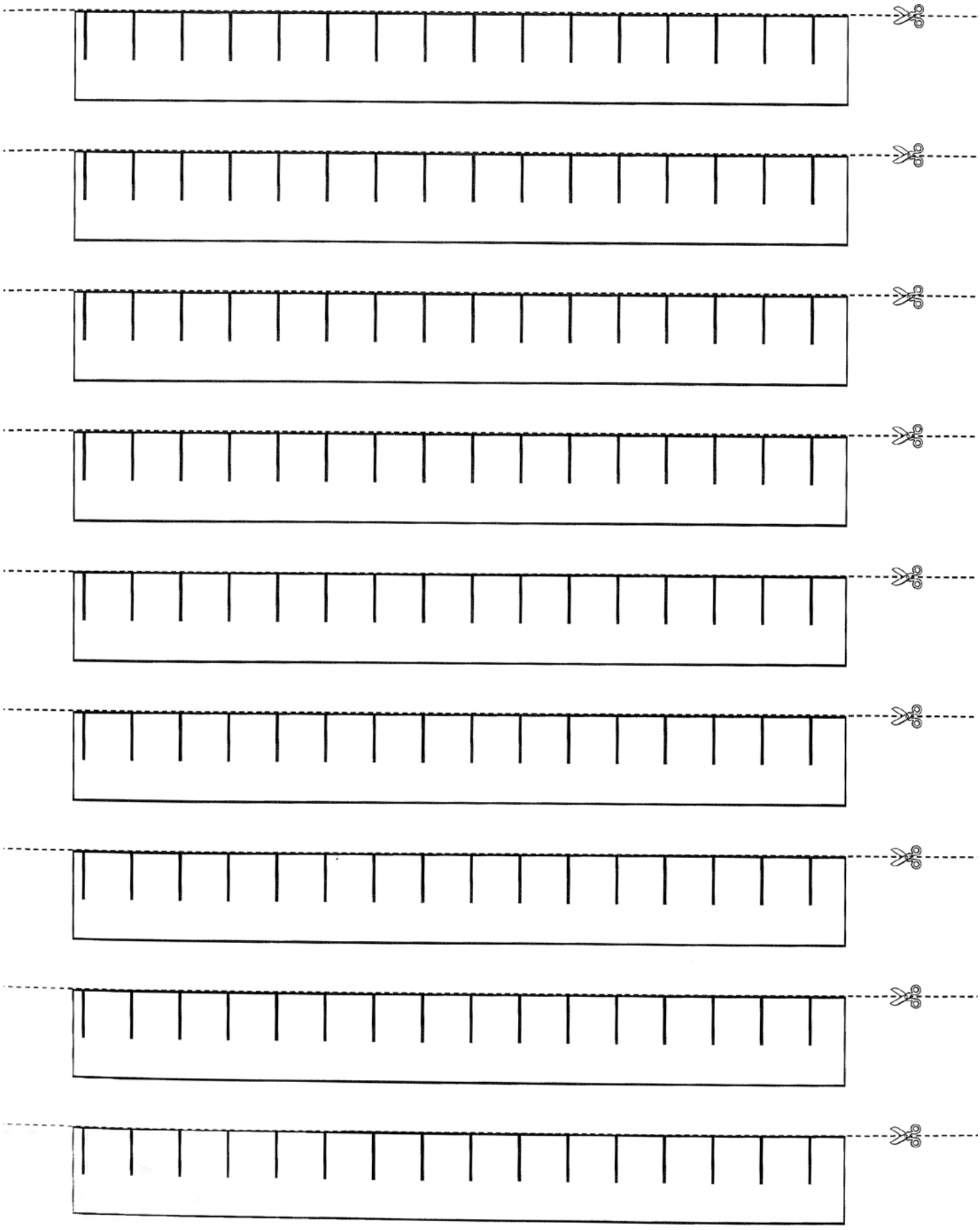
Broken Rulers

Resource Sheet E



Broken Rulers

Resource Sheet F



Introducing the GAIM materials.

We have decided to make the GAIM activities available to any reader who gets in touch. We feel they have great potential for use as a tool in supporting the development of mathematical thinking. Please get in touch, be emailing *Equals*, if you would like access to the materials.

I cannot really articulate this any better than Mundher Adhami in his piece on 'Old Bangers'. By focusing upon one activity he illustrates the worth of them all. What I will do is share some personal reflections regarding their importance to me as a rich source of engaging activities for pupils ranging from Year 5 upwards.

The most important part of each activity is the examples of pupil work that have been leveled, using the old National Curriculum from 2 up to 10. This shows the range of thinking possible in any one activity and therefore how it is possible to use with a wide range of learners. Because of this many schools use them as part of STEM or problem solving activities that last much longer than the standard 60 minute daily diet of numeracy.

Recently it struck me just how much a part of my personal teaching tool kit GAIM is. Over Easter I began to clear out my garage and found some pupil work from three GAIM practical activities. What I actually unearthed was something I tried with my daughter and her class when she was in Year 6 - she is now at St Andrews University! As I looked at the work the memories came flooding back, for that Summer I had been able to try several of them in the 'down time' following their KS 2 SAT's.

The photos below show the pupil activity sheet for three tasks, which happen to be the ones I try at least once every year:

- Cemetery Math's
- Planning a Flat
- Designing a Housing Estate

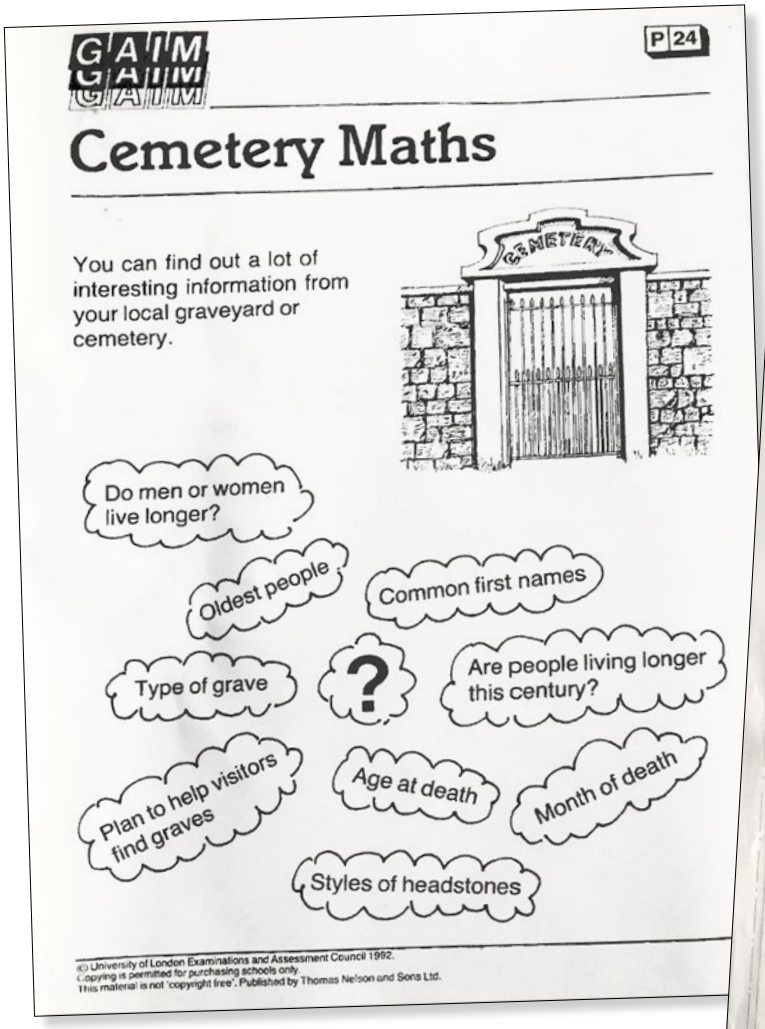
The 'Planning a Flat' activity is illustrated with photographs of my daughter's work, which are very interesting to look back on especially considering where the pupils are now. I wonder if you can spot which of the pupils is now at Cambridge?

For me it was the Cemetery Math's activity that was the most memorable, for we were able to use it as an opportunity to get outside and collect some real data. Following its use with my daughter's school I adapted it for younger pupil's which I first shared many moons ago in Equals (available from our archive). To set up the task I visited the school and spent about 30 minutes explaining the task and encouraging the pupils to develop their own hypotheses that could be explored by collecting real data from the local cemetery.

The following week both Year 6 groups had a morning out of school, well 9.30 – 11.30. We had a brief time of sharing where they said what

question they wanted to answer before walking to the local cemetery, about a mile way, where they were given one hour to collect as much data as they felt necessary. They were allowed to work in groups of up to four on this activity. Back in school we had a brief debrief and they were given the task of deciding upon the best way to present their data to help answer their question. I then returned the following week to present prizes during their awards assembly.

The GAIM activities allowed me, as a father, to bring some real enjoyment to the last few weeks of my daughter's primary school mathematics. Year 6 had been dominated by a seemingly endless focus upon the routine and practice that comes with any terminal assessment. She did not react well to such a high degree of conformity at the very time when she was blossoming into an independent thinker, someone who was very much in charge of her own thoughts and decisions. That 10 weeks GAIM, during which we were able to try around five of the activities, experience gave her a sense of control over the ideas she wanted to explore and, more importantly, the chance to work collaboratively on an engaging challenge that drew its inspiration from artifacts on her doorstep.


GAIM P 24

Cemetery Maths

You can find out a lot of interesting information from your local graveyard or cemetery.

CEMETERY

Do men or women live longer?

Oldest people

Common first names

Type of grave

?

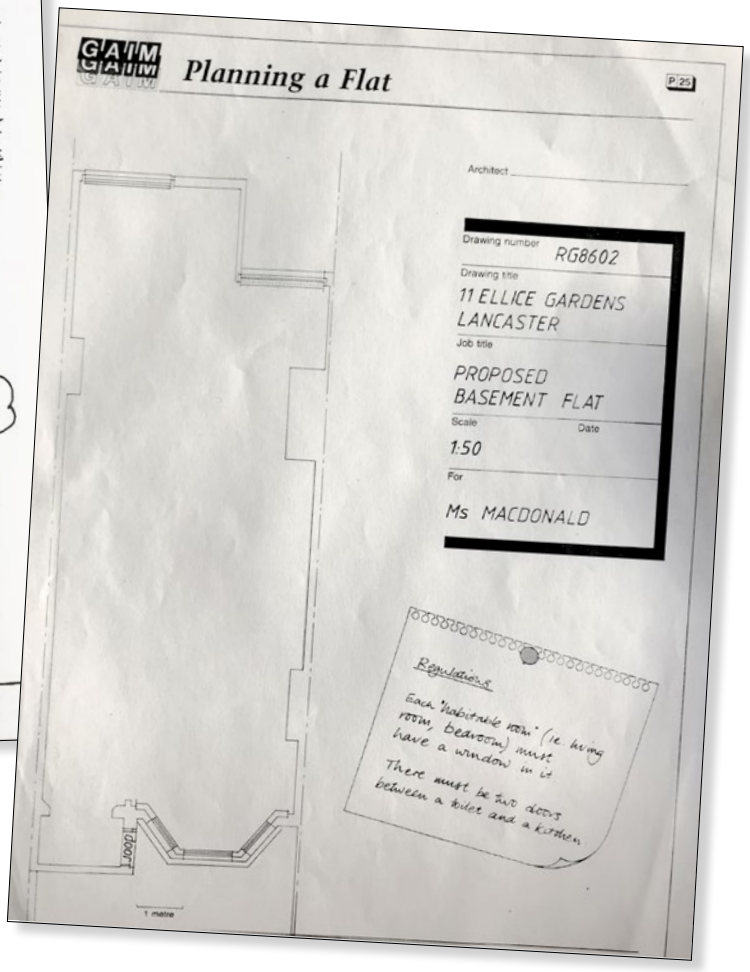
Are people living longer this century?

Plan to help visitors find graves

Age at death

Month of death

Styles of headstones


GAIM P 25

Planning a Flat

Architect

Drawing number RG8602

Drawing title 11 ELLICE GARDENS LANCASTER

Job title PROPOSED BASEMENT FLAT

Scale 1:50 Date

For Ms MACDONALD

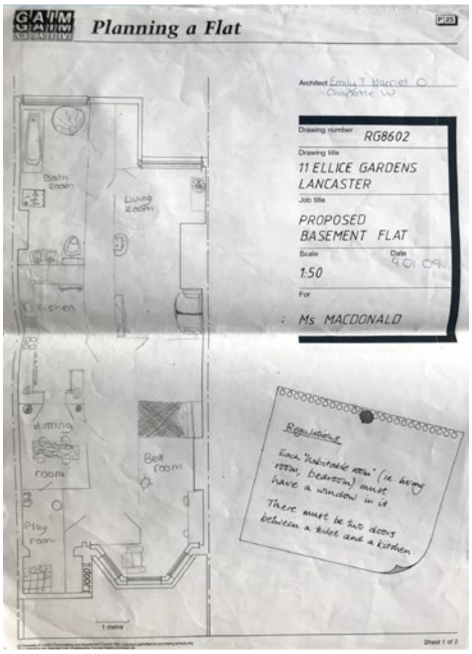
Regulations

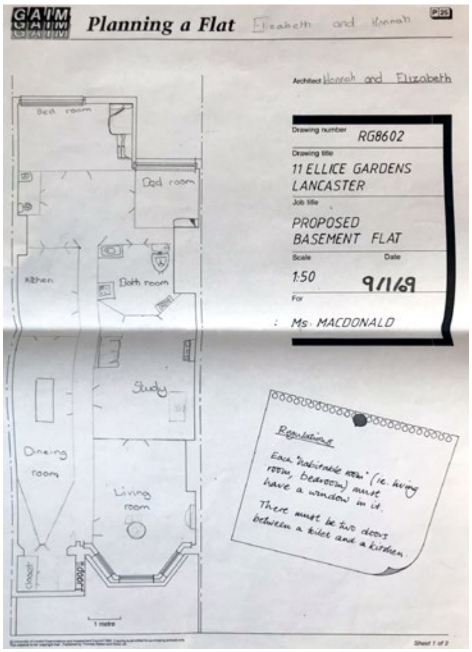
Each "habitable room" (ie living room, bedroom) must have a window in it

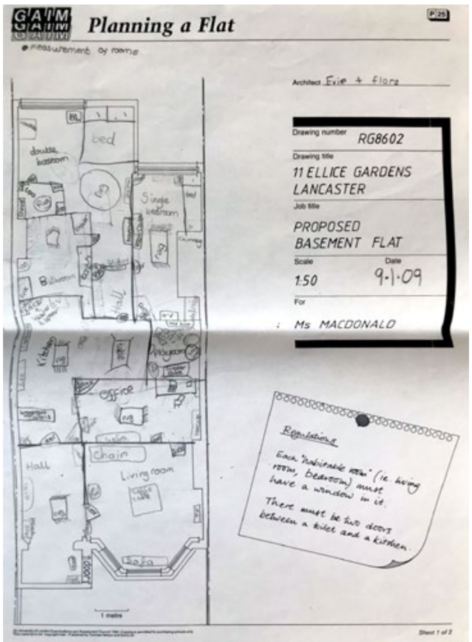
There must be two doors between a toilet and a kitchen

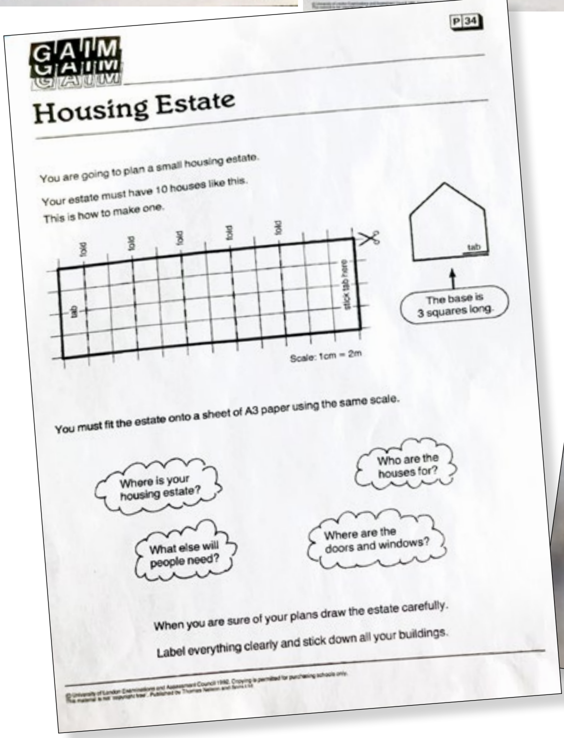
door

1 metre









Housing Estate

You are going to plan a small housing estate.

Your estate must have 10 houses like this.

This is how to make one.

You must fit the estate onto a sheet of A3 paper using the same scale.

Where is your housing estate?

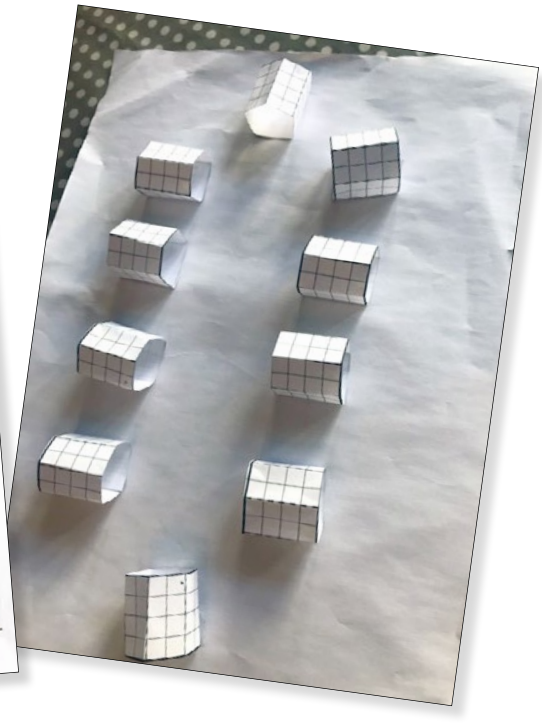
Who are the houses for?

What else will people need?

Where are the doors and windows?

When you are sure of your plans draw the estate carefully.

Label everything clearly and stick down all your buildings.



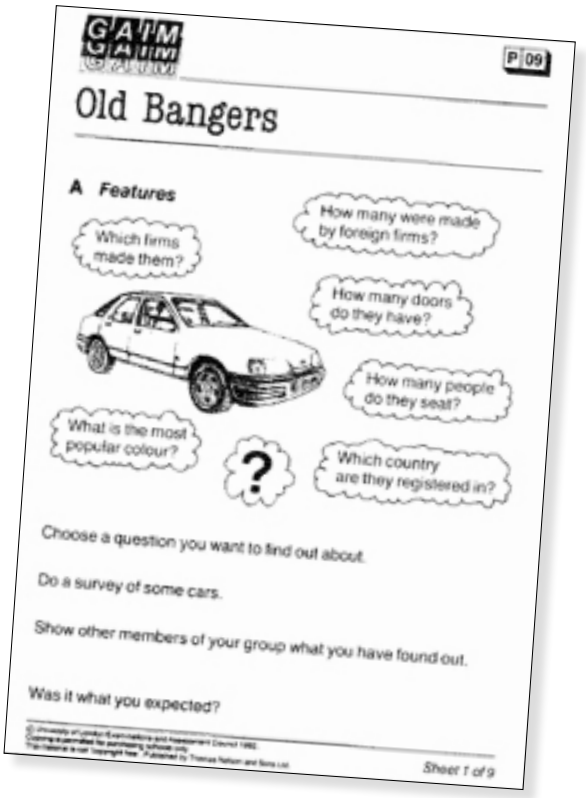
Old Bangers : a classic activity for all ages

Here is a popular real life activity for most classes in the age group 10-15. It is one of the 80 well-tested and enjoyable GAIM activities, each with guidance on a usually wide range of achievements.

(GAIM – Graded Assessment in Mathematics Education 1983-1991 directed by Margaret Brown, a Kings' professor made Dame in 2015 and Dylan Wiliam)

'Old Bangers' is a survey of familiar objects and one that can cover most of the programme of study on data handling. In fact, given enough time over a few lessons, it may cover the whole of the programme of study on handling data. Such is the power of well-crafted open-ended real-life activities.

The teacher's guidance offers ways of introducing the activity, using one or more of the small sheets below, or without them. The materials in the resource available online is dated (written about 30 years ago), but internet access can readily replace the printed sheets and update the activity.


GAIM GAIM P 09

Old Bangers

A Features

Which firms made them?

How many were made by foreign firms?

How many doors do they have?

How many people do they seat?

What is the most popular colour?

?

Which country are they registered in?

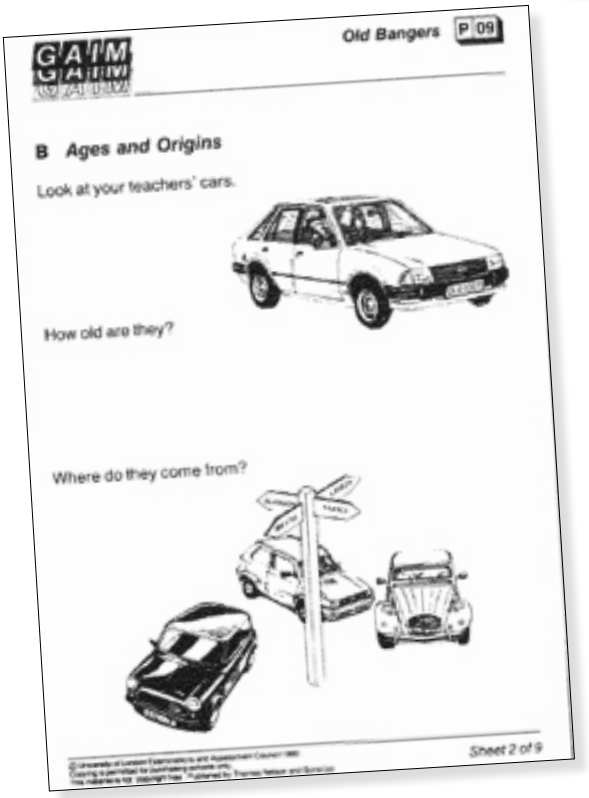
Choose a question you want to find out about.

Do a survey of some cars.

Show other members of your group what you have found out.

Was it what you expected?

Sheet 1 of 9


GAIM GAIM Old Bangers P 09

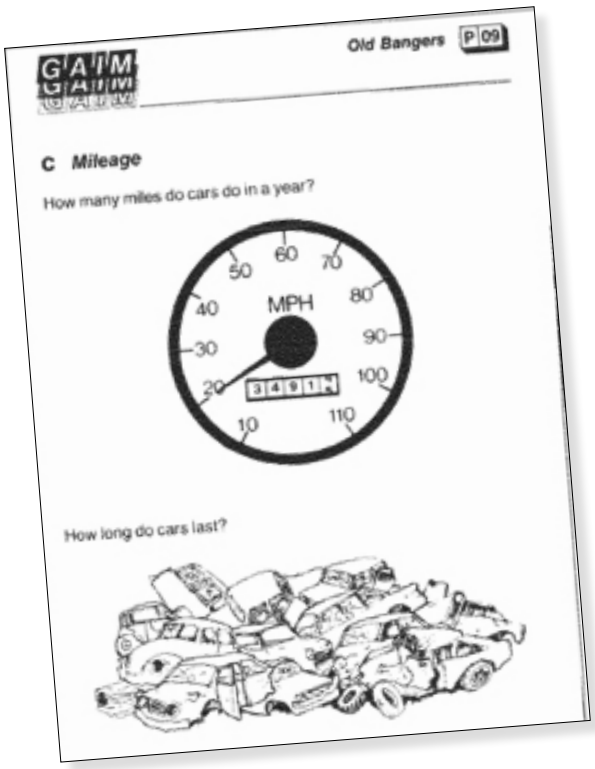
B Ages and Origins

Look at your teachers' cars.

How old are they?

Where do they come from?

Sheet 2 of 9



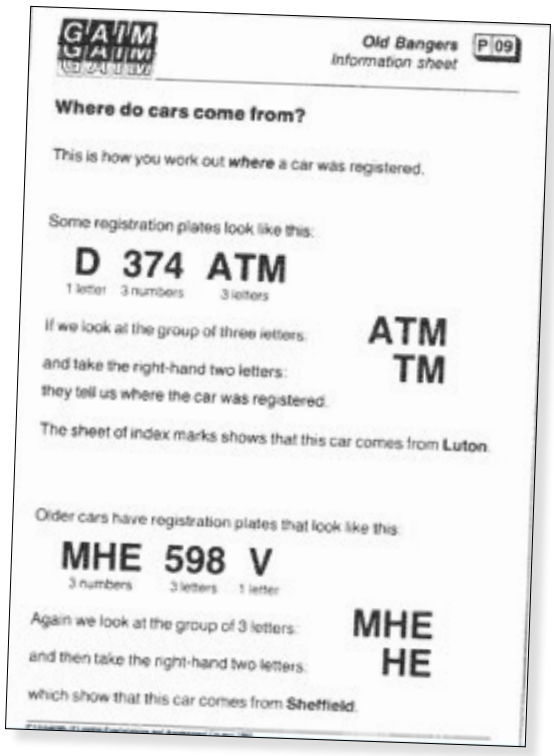
GAIM

Old Bangers P 09

C Mileage

How many miles do cars do in a year?

How long do cars last?



GAIM

Old Bangers P 09
Information sheet

Where do cars come from?

This is how you work out **where** a car was registered.

Some registration plates look like this:

D 374 ATM
1 letter 3 numbers 3 letters

If we look at the group of three letters: ATM

and take the right-hand two letters: TM

they tell us where the car was registered.

The sheet of index marks shows that this car comes from **Luton**.

Older cars have registration plates that look like this:

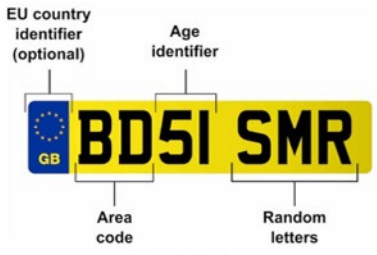
MHE 598 V
3 letters 3 numbers 1 letter

Again we look at the group of 3 letters: MHE

and then take the right-hand two letters: HE

which show that this car comes from **Sheffield**.

Here is an example of what is offered to replace the fourth sheet on the web page: thecarexpert.co.uk/how-does-the-uk-number-plate-system-work/



Engagement in a problem is a necessary start:

What I did with my classes involved asking all pupils to jot down makes of cars they knew. Then, scanning pupils' lists while they were busy (and knowing the pupils) I then called the class together and record all the car makes on the board starting with the makes offered by those pupils who wrote least (thus providing an opportunity for all to shine at this stage!). This recording of car-makes quickly ends with a long list to which all pupils contribute. I try to reduce the list to less than 10, (e.g. by combining all Nissans or VW s together). Then I pose the quick question: which of these makes we can call "Newish", and which are "Oldies"? I go for any agreement or semi- agreement. The aim is only to alert them to the age of cars.

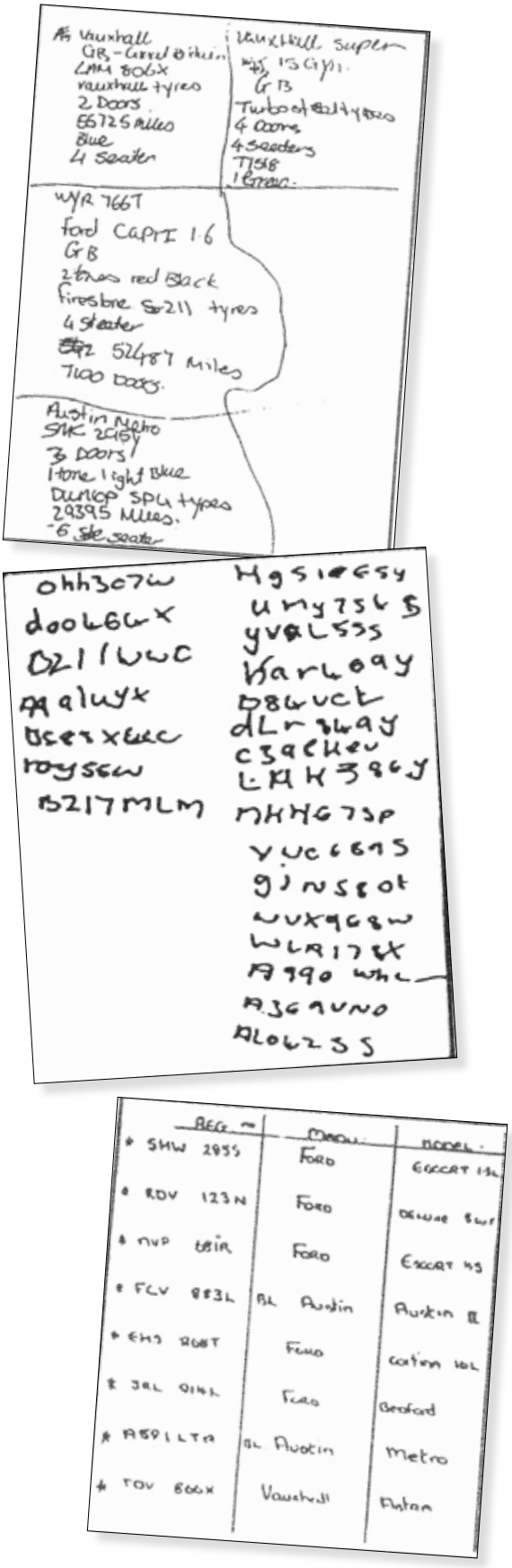
Then I pose the following question:-

- "What makes of cars do you think are most common nowadays in the staff car park? (or on the street on which the school is? Or at Tesco's car park?)"
- What car colours are dominant, which are rare?

Collecting real life data is a worthwhile challenge

Initially I allowed classes to decide how and what data to collect. Some just went out and wrote down the registration panel of the cars since we did discuss that the age of the car can be found in such panels. Others made systematic list of the panel and make of car. The resulting discussion helps pupils realise the value of being systematic. For some younger and low-attaining classes that may be sufficient with the rest of possible agenda being more guided or directly taught. The value of this part, i.e. posing the problem and collecting the data

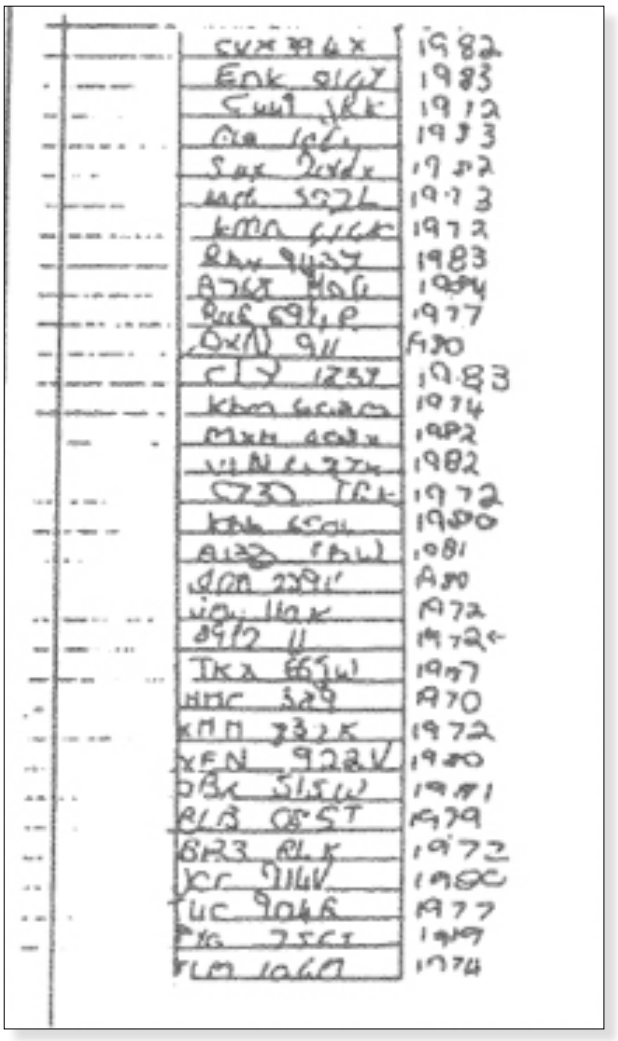
is ensuring engagement and sense of relevance to the pupils themselves. It also addresses skills of enumeration and being systematic i.e. how does one ensure that all the cars are listed and all the necessary data is recorded?

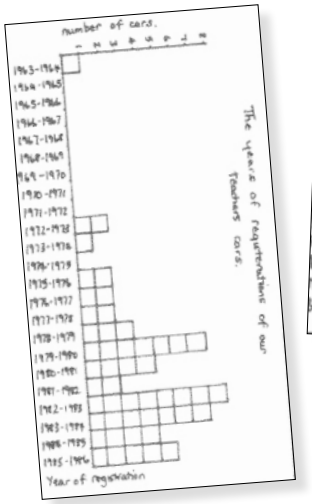


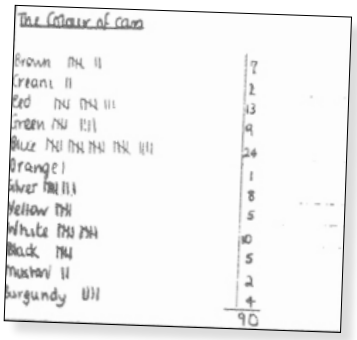
Organising data

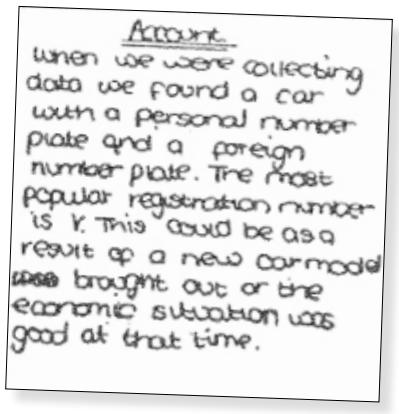
In some classes I wanted to focus on ways of organising and presenting data, rather than on collecting data. So we simplify and standardise the data collection. We agree that all the pairs or groups use a list with three or four headings, e.g. Registration, Make, Model, and Colour.

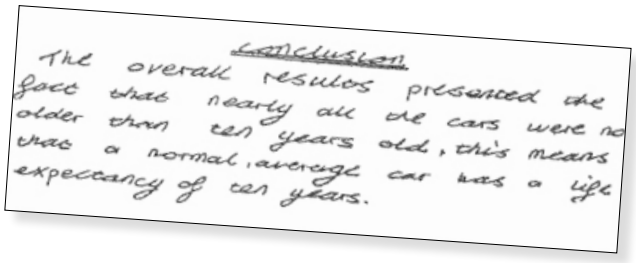
A variety of ways of organising data can emerge and the GAIM guidance shows some examples. Some are deceptively quite simple although requiring being systematic and matching data to lists, e.g. finding the age of the car from its registration panel. Others present the data visually as a bar chart. Yet others focus on the tallying the different colours.

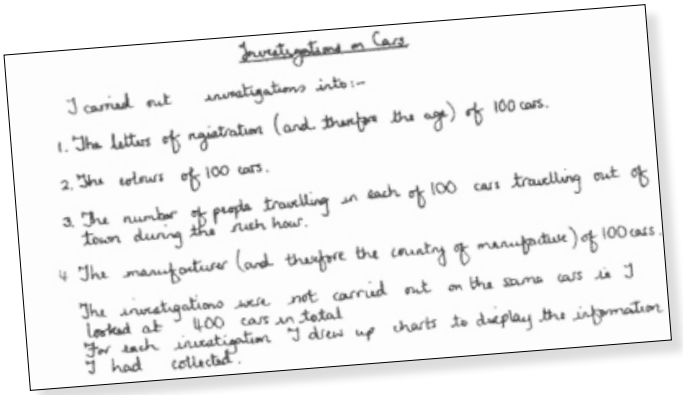






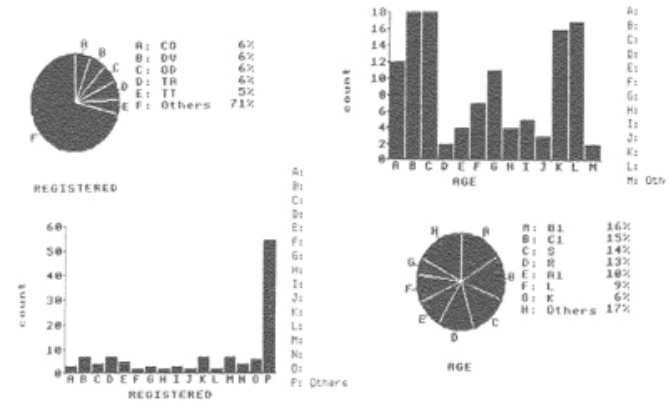






Higher achieving pupils may go to show data in multiple ways, and some may calculate angles in a pie chart, a high level skill in the secondary school. In all cases there are issues of accuracy, but the creativity and reasoning must be appreciated and discussed in class.

Using a computer database, into which they have fed their own findings, has produced several displ of summarised results which are a part of a coherent presentation.



Coming to conclusions

Interpreting the data and evaluating the work is the final phase in the activity and this can take the form of writing up the ideas that emerge from the data collection phase.

In evaluating work the issue of sampling invariably comes up. This is accessible across the achievement range. Pupils would speculate on how many cars are needed for a true conclusion, what areas in the city or the country the sample must be taken from and whether the data is actually exist on the internet.

A good end for the activity, which may take two or more lessons, is for the pupils to generate their own questions and to try to find more about ages, colours and usage of cars.

Mundher Adhami