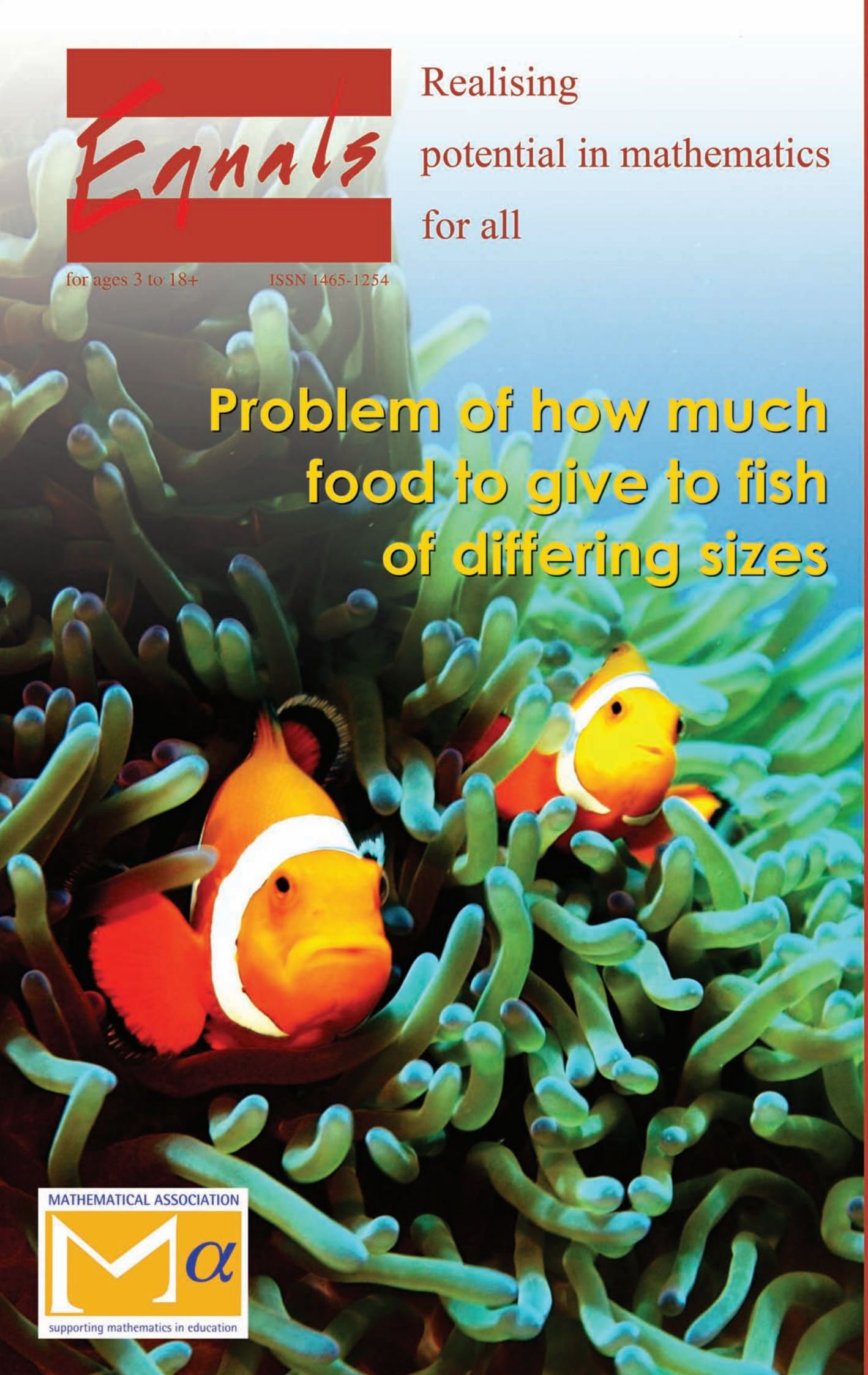
Equals

Realising potential in mathematics for all

for ages 3 to 18+ ISSN 1465-1254

Vol.16 No.1

Problem of how much food to give to fish of differing sizes



MATHEMATICAL ASSOCIATION
supporting mathematics in education

Let's all think maths anew!

Mundher Adhami writes about one of the best routes for developing responsive teaching skills. It is for groups of teachers to create new classroom mathematics activities starting from scratch, then try them together, and improve them. The mathematics is formally the same, but ways of teaching and learning are changing all the time!

There is much creativity in mathematics education at present. Just look at the choice of textbooks, websites and official documents. It is not only the Gifted and Talented children, or the SEN teachers who benefit from the plethora of new lesson plans, but all the mainstream teachers too.

But something is amiss. It seems that it has always been like this, but we still struggle with weak teaching and weak learning of mathematics. Just look at the real standards, not the test stats. But let's not go there!...

I think one of the main problems is that teachers themselves are 'consumers' of ready-made lessons and activities. Even when they plan lessons themselves, they do so starting from some ready-made assumption about the flow, or the order of steps in the topic. And the more creative teachers and writers produce their lessons and send them to be consumed. Multiple experiences by teachers might eventually turn into expertise, we hope. But often the role of delivering content gets in the way of the teacher really knowing what and how the children think and learn, and she just goes ahead and delivers the content.

teachers themselves are 'consumers' of ready made lessons

I suggest there are two ways out of this predicament. The first is that the lessons and classroom activities offered to teachers focus themselves not on formal mathematics, but on children's thinking and possible difficulties. Then the guidance on them should deliberately highlight classroom interactions, teacher listening and engaging with children's typical ideas on the topic. That means the lesson plans have to be trialled several times and common outcomes and misconceptions etc. noted. Some 'old' lessons and activities (e.g. in GAIM, CAME, much of SMP and SMILE) are of this type and I am sure many of the new ones are too. The guidance is variable, and I think without careful collective work in handling them, even the best are of limited value, except for teachers who are 'naturally that way inclined'.

This way of handling lessons carefully and collectively can actually be the second way out of the predicament. The lessons you use could be out there in the old texts, to be revised and looked at anew, perhaps with changed contexts and new slants to reflect the current youth culture. Or they could be fresh starts, with teachers starting from 'What do think the main problem is in teaching the X or Y topic?'

A group of us, mainly advisers who still teach in classrooms and experienced teachers in post (who often quickly end up as advisers) have been working in this vein for six years now. The work is based on the experiences of developing thinking maths lessons as part of university research based on socio-cognitive theories.[1] During the 11-year series of the publicly funded research projects we found that the best way to proceed is to be as responsive with teachers trialling the activities as we wish them to be with their pupils. That means you start with some idea of worthwhile conceptual challenges based on theory, but then are open to the teachers' own view of the difficulties. This in turn often means the teachers have to go back and reflect on their own learning trajectory, and also listen to their pupils. It seems that for many teachers, such reflection and listening have not happened before. So attending to how the children, and we ourselves, approach a concept from scratch, and talk about it in our natural daily language, seems to be a neglected aspect of teaching.

Currently we have become aware of how powerful this work is as a professional development route for both experienced and less experienced teachers. We are debating how to fund the continuing work, how to disseminate outcomes, and also how to promote the idea so that it works in the way we feel it is working for us. This article addresses this last point, and attempts to tease out the main principles of creating new *Thinking Maths* activities.

Here are some abridged quotes from the starting document on the collaborative design of new thinking maths activities.

General issues in designing Thinking Maths activities:

- The principles of design of CA (Cognitive Acceleration)-type activities need to be made explicit. These principles are not procedures but rather a combination of theoretical and practical considerations that must be coordinated. This line of activity is timely for experienced CAME teachers in the current climate in the country. Based on these principles we will be creating, testing and refining lessons for wider dissemination.
- Professional development models based on the creation and refinement of lessons need to be developed so that others can make use of them. Collaborative work on new thinking lessons has been shown to be more effective in improving pupils' learning than either generic thinking skills or narrow syllabus-focused or work-sheet based development. This may become a valid avenue for work with publishers.
- The main sources for new thinking lessons are:
  a) The detailed reasoning progression that underlies key mathematics topics. (Based on GAIM and CAME strands). This allows the topics to be explored in interactive and responsive whole-class pedagogy. This is closely related to the Assessment for Learning agenda now widely promoted by the DCSF.
  b) The fund of open mathematical investigations and practical problems, with documented or known pupils' outcomes. (Based on GAIM, ATM, BEAM and other materials). These are to be structured for challenging work in the appropriate range of attainment, to allow for creativity, enjoyment and excellence for all.
- The work will involve cycles of:
  * Whole group seminars around chosen topics and activities analysed for cognitive demand progression from the lowest to the highest levels, based on researchers' theoretical considerations and collective experience.
  * Small group planning work on appropriate pedagogy to address the challenges at the appropriate levels;
  * Team trial and observations with groups of youngsters, and
  * Reflection on practice, evaluation, and refinement of guidance for dissemination and further trials.

Cognitive match issues in selecting content

a) **Distinguishing the *reasoning agenda*** in the activity as distinct from the ***instruction or investigation*** agenda in a good lesson. In other words: distinguishing actual mental operations of generating mathematics in children's minds, mostly expressed in informal ways, from crystallised or bookish mathematics e.g in a good NNS lesson.
   - **How to avoid established or memorised knowledge and skills?** How to break through forms that create obstacles (e.g. the middle group pupils' insistence on the horizontal number line, using it as a procedure, with little attention to the position of a number on the number line in proportion to its size. They seem only secure in the procedural sense, so need extra attention to provoke independent thinking.) However, both the more - and less - able groups managed to generate ideas on the proportional placement of numbers on the number line. No such 'break-through' in the middle group,
   - **How to handle issues of context?** Sometimes context makes the maths easier; sometimes it adds to complexity. The simpler contexts e.g a simple story in familiar setting, and sensory motor activity of handling strips of paper may be preferable to using a whole set of materials, or complex stories, where diversions are possible.

b) **Distinguishing the cognitive range of children** from their mathematical knowledge and skills, as demonstrated through written tests.

Often children are graded in terms of school achievement in a way that does not match their real intelligence, i.e. the ability to process information in the mind and express themselves in informal ways. Hence the need to avoid giving too much credence to labels assigned to children, and to allow for surprise when a seemingly SEN child shines while a seemingly able child flounders because of an inability to think for themselves in a new environment.

There is **tension** between 'too-wide' a range in a group, and the need for open mindedness in assigning pupils to ability groups. We need to be careful about misestimating levels when we do not know the class. On the other hand an experienced teacher would recognise when the cognitive level differs from the achievement level of a pupil. We are having to develop a style of teaching that accepts that we do not know the levels of an individual pupil in the given context and challenge. Rather we increase the chances that the contexts and challenges are appropriate by attending to the range in a group!

how powerful this work is as a professional development route

Classroom trial issues.

These relate to the process of creating and trialing new Thinking Maths (TM) lessons or episodes in existing lessons.

- **Distinguishing near-strands in the mathematics - reasoning spectrum.** (Example of the Number lesson) While we assumed for the Number Line lesson that we were creating some access - or extension - cycles of an existing TM lesson, we found ourselves addressing a separate reasoning strand that seems to be ignored in the curriculum despite being of obvious value. In the existing TM lesson on the number line this is implicit, and now we have made it explicit. In effect we cannot beforehand, through mind exercise alone, plan a valid thinking lesson. Some aspects emerge only through open-minded trial and experiment with real classes.

  The distinction we made explicit is between:
  1. the number line as a model for quantity, which leads to recognition of equal intervals, organisation of number system e.g. in terms of 10s, 5s and 1s, proportionality, estimation

  and
  2. the number line as a procedure for calculation, either for both addition and subtraction, or at times for subtraction only, due to some misguided application of NNS practice. Here are issues of local 'cultures of teaching' leading to local cultures of learning by pupils.
- In the feedback following the trial we discussed issues of **responsive pedagogy**. The difference between **key questions** and **supportive questions**. Key questions can be pre-planned as they provide the main challenges in the range; they can be called strategic, and be included in the guidance. Supportive questions cannot be pre-planned but arise in response to pupils' ideas in the classroom. However the teacher can be alert to some typical potential responses, misconceptions and side-difficulties. (How much of that can be given in guidance? It may become unwieldy.)
- Some colleagues have **recorded children's ideas**, or collected their work. This can be very useful for analysing the lesson if time allows. Otherwise the notes and sheets can support the writing of short reports in professional magazines, or on a future CAA (Cognitive Acceleration Associates) website. We need to find ways of recording what children think. There has been some success in videoing children working and framing discussion around the clips. The more adept we are in technology the more that is useful. But the key factors are time allocation and having a frame for analysis, however flexible.
- **Readiness for a second round on the same lesson.** I think we are ready now for a second trial based on the two versions I suggest below. Colleagues may wish to do things differently, but there is value in doing the same versions and discussing both the process and content next time. I hope colleagues will jot down a few ideas on their trial.

We have talked about the trial of **other lessons** which individual colleagues may like to start developing. It makes sense to work on one extra lesson at a time, in addition to the one we are all trialling. Colleagues may even start their own journal, recording both the specifics of a trial or more general comments.

One issue we touched upon only slightly is the **relationship with the trial class teachers**. I suggest we pay attention in the future to winning them over to the approach, and at least to the trial. This may mean briefing them, asking them how best to organise, what they think we should do, eliciting their help. It may well be the case that we should trial lessons only in Y5 or Y7 and avoid year 6, so that we don't risk what may look like interfering with teaching for the test.

The outcomes

Over the last 6 years over 30 new Thinking Maths activities have been created in this way. 10 of these have been placed in the new edition of the Secondary Thinking Maths folder. The others are still in various forms of drafts, since they are in continuous trials. Many of the articles in *Equals*, written by Jane Gabb and myself, both members of the editorial group of Equals, and by Alan Edmiston, Sarah Seleznyov and Lynda Maple amongst others are based on these new activities. We write with the intention of showing how teachers and pupils actually responded to a lesson and so that teachers could try the activities themselves in their own classrooms. We are keen to continue this work, and would welcome feedback from all teachers.
For additional material you may look at the website www.CognitiveAcceleration.co.uk/

You can find more background on

www.kcl.ac.uk/schools/sspp/education/research/projects/cognitive

Cognitive Acceleration Associates.

1. *Thinking Maths*, published by Heinemann/Harcourt, Primary *CAME Thinking Maths* (PCAME) published by BEAM, and the two *Let's Think through Maths* packs published by NFER-Nelson (now GL Assessment). They were part of the outcomes from a series of research projects from 1993 to 2004 at King's College London, based on neo-Piagetian and neo-Vygotskian theories.

NCETM website

Jane Gabb explores what this website might have to offer readers of Equals.

I started off by searching the site. I put in 'low attainers' and found several discussions. 'Making mathematics real' contained an article about the myth that low attainers should always be taught mathematics in the context of everyday problems like tax, interest etc.

'They are just as likely to be motivated by the fantastic and mysterious as the maybe useful. We must not protect them from the fantastic and mysterious – the awe and wonder – in mathematics.' And 'An interest in the creative, investigative, puzzle-solving side of mathematics may provide them with many happy hours of entertainment.'

Someone had told me about 'The good teacher – good student deal' so I put 'good teacher' in the search engine and got straight to this good idea posted by an NQT who had observed this happen in a classroom:
'At the beginning of the class the teacher, who had this class for the first time, asked them to tell her what made a good teacher, i.e. whose classes they enjoyed and learned from. They came up with things like "has to be fair", "has to be fun", "has to be respectful" and "should not shout". She wrote all of them down on the board and then asked what made a good student.