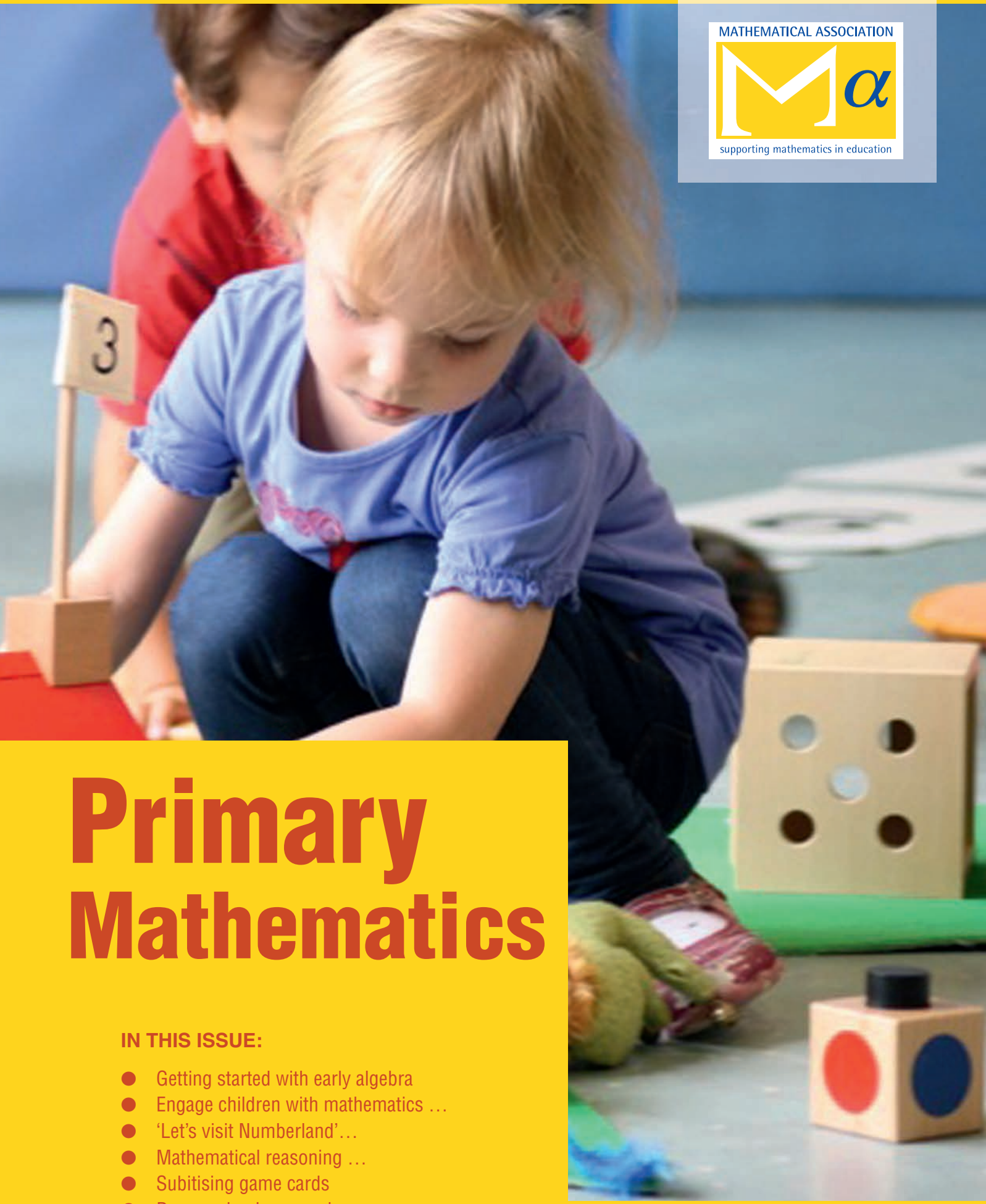

MATHEMATICAL ASSOCIATION

supporting mathematics in education

Primary Mathematics

IN THIS ISSUE:

- Getting started with early algebra
- Engage children with mathematics …
- 'Let's visit Numberland'…
- Mathematical reasoning …
- Subitising game cards
- Progression in reasoning
- Creative Digital Mathematics…

SPRING 2015 • Volume 19 • Issue No. 1

Engage children with mathematics like never before

Franz Schlindwein introduces Izak9 and describes how it helps to develop reasoning

My research and experience has shown that two of the main reasons why children in upper primary school are most likely to disengage from mathematics are that their learning has become more solitary and isolated and they no longer learn through play. Maths for these children has become tedious, repetitive and boring. They may experience solitary worksheets and time spent alone at a computer screen along with fewer and fewer methods by which they can physically interact with mathematics and with each other. Few genuine collaborative learning opportunities are available to them and these are vital to kindle any enthusiasm for mathematics.

As a former head of mathematics with extensive experience of working in the Primary School sector as a teacher, parent and school governor, I decided that I wanted to create resources that could offer a variety of opportunities to all the stakeholders involved in the teaching and learning process. My priorities were initially to devise a method which would engage pupils of all abilities and preferred learning styles and provide a stimulating and rewarding shared learning environment for peer learning, all of which would help raise attainment by ensuring that every child is seen, heard and recognised, elevate thinking skills, build confidence, raise attitudes and dispositions to mathematics and improve communication skills.

In addition to the benefits to pupils, we wanted to provide support mechanisms to teachers that could help accelerate children's learning by honing such techniques as formative assessment, positive teacher intervention, inclusivity in the classroom, collaborative learning and effective questioning.

As a result of working together with universities, schools, parents, product and web designers, font and graphics specialists, 3D animators, programmers, precision engineers and manufacturers and Invest NI (our UKTI in NI), the unique and innovative active learning device we have designed is called Izak9.

Not only is Izak9 proving to be a highly effective teaching and learning tool for use in the classroom, it is also leading the way as a method by which to deliver the highest quality interactive CPPD training for teachers. We have also been using it to rave reviews with parents and children to deliver numeracy/maths based family evenings in schools.

So, how does Izak9 work?

Izak9 consists of a system of 27 colourful and captivating cubes. These cubes combine to form a 3×3×3 structure as shown (picture 1). When deconstructed, this larger cube can be separated into 3 colour coded groups of 9 cubes each set of which can be used by a group of 4–5 children. Normally 2 sets of Izak9 cubes are in use by a class of children at any one time, thus facilitating classes of up to 30+ children if required.

The physical cubes are used in conjunction with a suite of HD animated e-learning materials, which can be accessed either by projector at the front of the room or by tablet devices. The children are set tasks by two 3D animated characters – Abacus and Helix. These two affable robots use an identical set of

virtual cubes to facilitate the tasks and the associated questioning. The teacher can use the animated content as he or she sees fit, depending on the ages and ability range of the children in the class.

The idea is that children of all abilities and preferred learning styles can work together in groups and, using a combination of the physical and the virtual, access a variety of stimuli across many levels. Each task involves Abacus and Helix asking the children to construct a wall of cubes according to a given set of instructions. Once children have arranged the cubes in a way that provides a solution to the task posed by our two friends, they display the arrangement of numbers as a vertical wall. This ensures that every group's solution can be shared with all the children in the room. This is the first part of the task. The essence of what happens next goes back to Plutarch and 'children are fires to be lit, not vessels to be filled.'

Rotation of team captain – responsibility and social interaction

Pupils work together in groups on the tasks posed by Abacus and Helix. For each task, a different team captain is chosen. This is to ensure that every child gets the opportunity to lead a task as well as the opportunity to take direction from others. Izak9 is a capacity building device and the development of these interpersonal skills is very important, especially for the more solitary, academic learner who will often traverse the path through school life avoiding any prospect of having to articulate his or her thoughts, mathematical processes or problem solving strategies to others. Izak9 offers this type of learner a lot of stretch in this regard.

Plan, Do, Review and Make Sense – elevation of thinking skills and building for the future

The PDRM evaluative loop is integral to the most effective use of Izak9. Pupils' thinking skills are elevated by the clear sense of purpose by which they can go about solving an Izak9 task together. It doesn't matter how long children spend on each section of this loop, as long as the planning stage is done well. Once pupils have a Plan in place, they Do the task, Review the team effort and then, stand back, take a good look and ask 'Does our answer make sense?'

This cycle not only very quickly becomes embedded in how children go about solving all the Izak9 tasks, it also becomes a methodology for approaching any task, either in or out of the classroom.

Formative assessment – assessment for learning

The fact that pupils have a physical product, a shared learning environment, animated stimuli to focus them between tasks and a PDRM methodology by which they can operate together means that there are abundant formative assessment opportunities for the teacher. He or she can clearly see how children are learning, who is responding to what stimuli, who is communicating effectively, what particular areas of mathematics the children are excelling at, what areas is it obvious that they will need support with and who is having a positive influence on the group. All these scenarios and many more are accessible to the teacher.

Effective questioning

During the construction phase of each task and once a wall of numbers, colours and shapes has been built by the children, the teacher can discuss with children their various approaches taken to solve the task. When this phase is finished, he or she can then either use the banks of questions available via the software or devise questions themselves based on topics they may be currently addressing. There are selections of question by type (video, audio, written) available as opposed to simply different mathematical topics and degree of difficulty. For example, with a wall of yellow circles (the pupils are directed by Abacus and Helix to build a wall of yellow circles) the teacher could open a discussion on the properties of primes

and do some associated number work. He/she may want to offer a more open ended task, such as: If we use this selection of numbers and the number operations of addition and subtraction, can we generate more prime numbers? Children can work together on this task and come to conclusions in their own groups, which they can then share.

The key here is for teachers to develop the ability to not only ask open and closed questions, but to be able to pivot and adapt the lesson according to the responses of children. This can be challenging but the rewards can be enormous since children will still associate this learning as emanating from themselves and not from the teacher, giving them ownership and responsibility for the positive nature of the outcomes. For example, when asked to find the sum of the numbers in the circles displayed on the wall of multiples of 3 (picture 3), children have given us many different methods by which they have achieved an answer of 75. One method in particular was very advanced for a child of 9. He said 'I just multiplied the 15 by 5 to get 75'. When asked why he used this method, he replied 'The difference between each circle is the same, 6. Because the difference is the same and we have 5 numbers, if you multiply the middle number by the number of numbers, 5, then you get the answer 75.'

It is magnificent to get a response of this nature in the classroom, and even more so that a child is able to articulate his method to both the teacher and his peers, in the manner described. The teacher being able to facilitate this happening is good practice in itself, but there is a serious opportunity for stretch here. A suggestion would be for the teacher to introduce an idea to the class such as 'would there be any way in which the class could investigate this approach'. The nature of how this stimulus would be introduced is obviously important and highly dependent on the ability range of the pupils in the room, the key being to leave it as open ended as possible to allow the children to come up with as many ideas of their own on how to pursue the task.

Positive teacher intervention – often minimalist

In addition to quality peer learning and receiving positive feedback, the nature and timing of teacher intervention can add real value to accelerating a child's learning.

For example on the wall of numbers already shown in picture 3, the first question asked is, 'What is the product of the numbers in the top row?'

Similarly to the 'sum of the circles' question, we have received a myriad of different answers to this question. An example of best practice would be, 'Now that everybody has attempted the question, would any group like to volunteer to go first?'

'May we go first?'

'Absolutely, go ahead'

'We did 3 multiplied by 9 is 27. 6 times 27 is 162'

'Brilliant, well done and what did you do with the 6 and the 27 to get 162?'

'We multiplied 27 by 3 to get 81, then doubled 81 to get 162'

'Excellent work, really well done and had you any particular reason for choosing this method?

'I can multiply anything by 3, so I multiplied the largest number by 3 to get 27 and then because I know six is two threes, I multiplied by 3 again to get 81 and then doubled my answer.'

'Fantastic, great work and very well explained.'

There are many advantages in getting to the 'how' and the 'why'. Not only does it do wonders for a child's confidence to be able to articulate these methods to his or her peers, which provides a wonderful opportunity for them to develop their processing and communication skills, it also recognizes and rewards the efforts of the child by identifying that particular method as being special to him or her. Instead of simply having an arbitrary list of various methods by which each question can be attempted, you have little capsules of what is going on inside a child's mind that is precious to each individual, yet each can be shared with everybody in the room.

Value of team – peer learning (Vygotsky)

Group work is often cited as being of great value to pupils, but this is only true if the children can work effectively together in the group and if each child gets the opportunity to boost their own confidence and self-esteem by being able to add value to the group dynamic at some stage during the cycle of activities.

The PDRM evaluative loop adds structure to the group's efforts and has an ongoing positive effect. The real strength that Izak9 has to offer a group is that all the stimuli on offer are varied, so that there is a greater chance that at some stage during the learning process, a child will be able to make a positive contribution based on their own preferred learning style.

For example in the 'sum of the circles' question already mentioned, we have children presenting methods visually by spotting number bonds – 'I added 3 and 27 (pointing to both simultaneously), then 9 and 21 (pointing in similar fashion), finally adding 15, which makes 75'.

Some adopt a more traditional strategy, attempting to add the numbers in increasing order, but then discover something in mid-flow.' I added 3 and 9 first, then 15 to get 27 but now I have a total of 27 and am distracted by the other 27 and decided to go that way instead of the 21, double 27 to get 54, then add the 21, to get 75.'

We also get children who prefer to have the numbers called out, listen and then add.

In some cases, we have had children actually physically remove the cubes with the circles from the wall, manipulate them into the preferred arrangement for them to find the sum, then perform the operation. These methods are indeed only a snapshot of the variety of approaches we have seen to this question.

Learning pyramid – question sharing to question posing – Eliminator

Another of the principal attributes the use of Izak9 has to offer is the facility to provide children with opportunities to create content of their own.

The Eliminator round uses the wall of single digit numbers (or any of the other walls if desired). The children are given a statement. They then remove the number associated with the statement from the wall.

For example:

Eliminate the number of sides on a pentagon.
Pupils remove 5.

Eliminate 72 divided by 8.
Pupils remove 9.

Eliminate the missing number from this sequence. 1, 2, 4, blank, 16, ….
Pupils remove 8.

Eliminate 52 minus 45.
Pupils remove 7.

Eliminate 4cm minus 36mm in mm.
Pupils remove 4.

Each group is now left with 4 numbers. The idea is now to give them a multistep question on which they work together. In this case we now have: 1, 2, 3 and 6 remaining.

The pupils are asked to use all the remaining single digit numbers and the 24hr clock to make the time closest to 1pm.

One example of what happens is that pupils say 'OK, 1pm is 13, this leaves 2 and 6' – so they build 1326 as a solution. Then their Plan, Do, Review and Make Sense kicks in, along with the fact that they have a physical product, which they can manipulate! In the vast majority of cases pupils will take another look, ask questions of each other and change their first effort to 1236, realising that it is a better answer. They will then be able to articulate the process by which they arrived at this conclusion and appreciate that their first effort of 1326 was not wrong, but merely a step in the right direction upon which they were able to build.

This is a great task in its own right, but the real added value comes when the teacher is able to suggest to his or her own class if they would like to design an 'Eliminator' round of their own and ask the questions of the other teams. Not only can the children then be creative in designing their own questions, they must choose 4 numbers for the purpose of designing a multi-step question, write 5 questions to eliminate the other 5 numbers and finally pose these questions to their peers.

Izak9 is being used to tremendous effect in an ever increasing number of Primary and Post Primary schools across Northern Ireland and can be readily adapted for use with any mathematics curriculum to support the teaching and learning of mathematics.

This article only scratches the surface of the activities available within the ever expanding portfolio of Izak9 tasks and provides merely a snapshot of some of the potential benefits its use can provide for pupils, teachers and the whole teaching and learning process.

For further information contact **Izak9's** creator **Franz Schlindwein** at **franz@izak9.com** or visit **www.qubizm.co.uk** or **www.izak9.com**