

Effective questioning

in teaching mathematics

using an interactive whiteboard

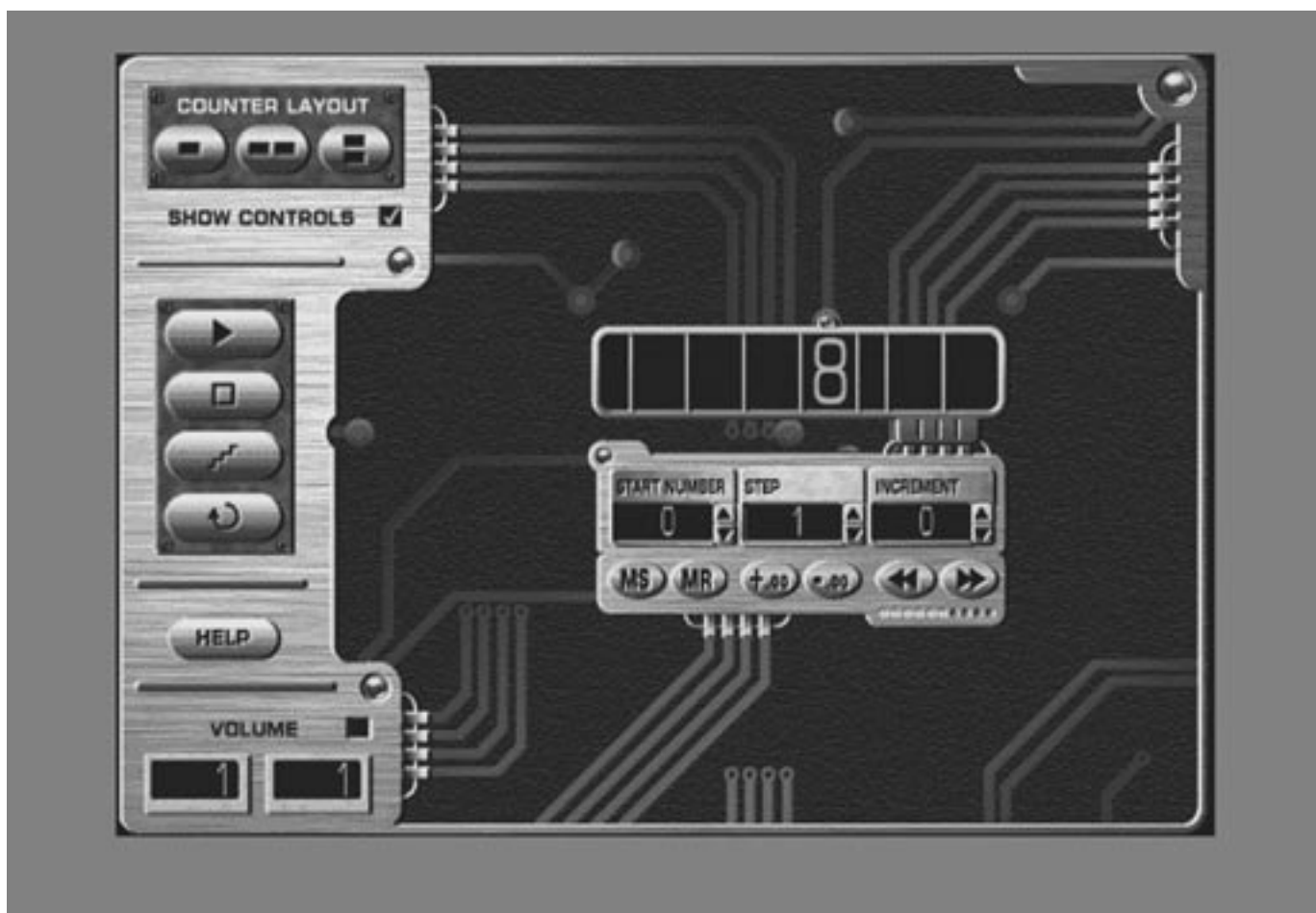
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Introduction

The Primary ICT Pack accompanying the National Numeracy Strategy for England and Wales provides some programs for use in the classroom. Here, I describe a lesson with a Year 5 class (9-10 year olds) in which I use an interactive whiteboard and two of these programs.

Starter

The initial activity was designed to engage the children's attention and gently introduce the concepts. By using 'Counter', I was able to demonstrate number sequences quickly and easily. We were all able to share the display by using a data projector and interactive whiteboard.



'Counter' used on an interactive whiteboard

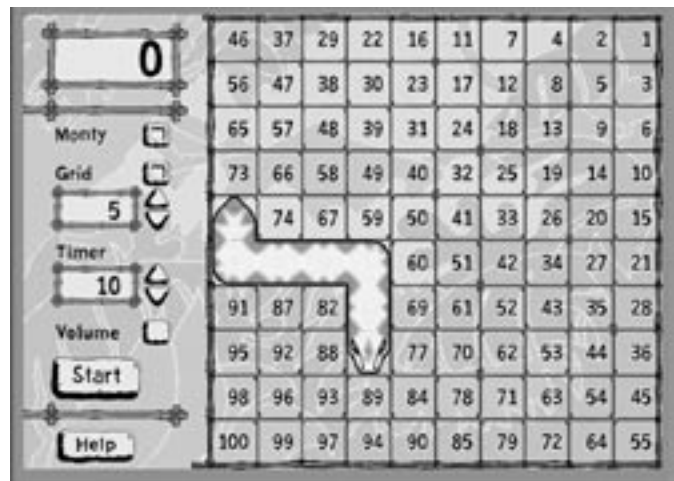
During the activity I posed questions which developed the children's thinking so their learning progressed. For example, by asking questions such as 'What number comes next?' or 'Why?', we were able to demonstrate how a sequence of numbers is formed.

I stopped the counter at various times and asked for responses that would allow the children to demonstrate their understanding. For example, 'Continue this sequence' or questions such as 'What was the previous number?' or 'What is the relationship between the numbers?' This enabled me to extend their thinking by creating a discussion about the properties of the numbers. For example, they are all odd, multiples of X and so on. We then used 'Counter' to begin to develop reasons or rules for the sequences. Questions to prompt this included 'What is happening to the number each time the arrangement is increased?', 'Tell me how it is getting bigger', 'Can you spot a rule to explain how or why this is happening?' These questions enabled me to begin to understand how the children arrived at their answers: their mathematical reasoning.

The 'Counter' software used was extremely useful as an effective teaching tool. It could count large amounts of numbers very quickly, in any sequence or pattern. If these sequences were to be displayed to the children without the aid of ICT it would involve writing streams of numbers on the board either before or during the lesson. The ICT was able to demonstrate a sequence and therefore prompt questioning and discussion. The children could see how the numbers followed each other, growing in amount of digits and their value, first with the rule displayed then without. I was able to select an appropriate rule for a sequence according to the abilities of the children. The ICT enabled effective, flexible and diverse teaching that could be pitched at the abilities of the children.

I also asked children to set up the 'Counter' to count a desired sequence. This was in order to assess how well the children understood the way sequences were formed. I supported this process through direction and questioning: 'What is the start number going to be?', 'In what steps would you like the machine to count?', 'What mathematical function do we need to input in order for the counter to count in the sequence?' We went on to test the functions and evaluated why they did or did not work. 'What number do you expect to be at the end of the sequence?', 'Which numbers will be included?', 'Which numbers will be missed out of the sequence?'

In the main activity introduction I used 'Monty' (available to download) to develop the mathematical concept and to extend it to identifying missing numbers



'Monty' on the whiteboard covers some numbers. Can the class remember the number sequence?

The main activity

in a sequence. Sharing the program on a large display and questioning during the initial shared activity was crucial for learning. The initial questions were directed towards the patterns of numbers on the displayed grid: 'How are the numbers arranged?', 'What steps do the numbers go in?', 'By what are the numbers increasing or decreasing?', 'Is there a sequence?' Once the children had become familiar with the patterns on the grid I used Monty to cover over some of the numbers. The children used their knowledge of the sequence to find the missing numbers. I facilitated their thinking through directed questioning. For example, 'Look at the numbers at the beginning of the line, can you remember how the numbers were increasing?' I encouraged the children to check their answers by using their knowledge of how the numbers were arranged down the rows on the grid: 'Do you still get the same answer if we look at the numbers down the rows?' This routine was repeated several times in order to practice and consolidate the concept, and as an opportunity for me to monitor the learning.

For the main activity the children worked in groups on two computers, using 'Monty', or individually on paper. I initially supported the groups on the computer to ensure they were familiar with the workings of the software, and with the task instructions. I then supported the groups working on paper for the most part. During the activities I did intervene with the children using ICT asking: 'Why have you chosen that number as being the one missing from the sequence?', 'What is the rule of the sequence?', 'What would the numbers be at the end of the rows?', 'Why?' For a small part of the lesson, I became an observer of what the children were

doing. I stood back and listened to their interactions with each other, observed their achievements and identified times of difficulty when extra support was needed, or when greater extension was necessary. This was achieved through giving the children simpler or harder grids to complete, or re-setting the time to view the grid before it disappeared. By asking the children to write an extra row to the grid I had evidence to assess the successes of the individuals in the group.

The plenary session was planned to give the children the opportunity to demonstrate their learning and therefore self-assess their own knowledge and understanding, and for me to assess and monitor the learning of all the children. I was interested in their ability to set up a sequence, give the next number in a sequence and describe the method used to calculate missing numbers

Plenary

in a sequence. Later marking of the children's work enabled me to see if learning had been enhanced by the use of ICT as I made small comparisons to those working on paper. This information was recorded on my daily evaluation sheet.

At the end of the plenary session I asked the children why I used ICT as a tool for teaching and learning. Responses were mixed, including 'it is fun' and 'you love ICT miss!' A discussion developed about why the ICT was useful, how easy they found it to use and how helpful it was for me to demonstrate and explain a concept.

The pupils were highly responsive to the activity. They used reasoned thought, drew on previous knowledge of the number system and answered my questions well. By the end of the lesson they could identify the next number in a number sequence, recognise the rule and offer methods to find this rule. Often they needed support and step by step questioning in order to reach the final goal but this became less so as the lesson progressed to the

The outcome of the lesson

point where most could work independently of direction from me.

During the lesson the children were asked to consider their own ability in recognising number sequences. This was achieved by the children stating a personal 'tool kit' of methods to extend number sequences, their success in tasks given, and correct responses to questions.

The children's self-esteem and sense of achievement were increased. The activities were also successful in

showing the extent of the children's understanding. They highlighted for me where any misconceptions lay as well as identifying individuals and concepts that could be extended.

I believe that the use of ICT, in this case, enhanced learning. Many children who find mathematics difficult and frustrating begin to associate failure with a negative response from the teacher. This, as Holt (1994) says, creates apprehension and leads to subsequent failure. The ICT in the lesson served to remove this apprehension as the 'Monty' program had a reward screen, which came up when the children succeeded. This seemed to increase the children's self-esteem and encouraged a feeling of success. The ICT was a

The value of ICT

tool to ignore the 'wrong' answers and positively reward and reinforce the correct answers. The children demonstrated this when they stated how many times the snake waved his flag; they appeared to be proud of their achievements, enough to want to share it with the rest of the class.

Some children seemed to be aware of steps needed to extend a number sequence but came to the wrong solution. These children could demonstrate understanding with the aid of ICT but struggled to transfer this knowledge without it.

Did the use of ICT 'mask' their learning? ICT allowed children to achieve by supporting the basic skills involved, doing the counting for them. It seemed to me that the children involved in the lesson understood the concepts of number sequences and had the related skills to extend sequences by three or four numbers, but made mistakes when they were asked to count the sequence manually. It was important to notice that these children would need more support in their basic skills even though they appeared to be attaining a higher level.

In contrast to this, ICT could also hinder learning. For example, in the group work, the children spent a good 5 minutes re-familiarising themselves with the software and the functions of the 'Monty' program, time that could have been spent practising or demonstrating what they knew. At first, one group were struggling to get the predicted numbers to be displayed on the screen. It was a simple matter of pressing the enter key, but still time was lost and frustration crept in. This group of children ended up completing fewer tasks than the other group, not because of lack of capability. There was 'a temporary dip in attainment' due to the workings of the computer. Here, apparent attainment misrepresented

actual capability, a matter that would not have arisen using pencil and paper.

I tried to prevent ICT misrepresenting the attainment by taking into account what I knew about the children's capabilities. I created opportunities for the children to demonstrate their knowledge without the use of ICT, and planned to develop the lesson objectives to consolidate understanding in different contexts in the follow up lessons.

Because the software allowed many calculations in a short period of time, my expectations were different for those working on the computer. Firstly, I expected a greater amount of calculations to be done and to a greater degree of accuracy, given that the computer checks the answers. I also expected those working on the computer to develop more logical thinking and be able to more readily modify strategies and assumptions (see Oldknow, 1999). When using the computer the children appeared to have a greater understanding of where their own misconceptions lay. For example, I heard one child at the computer state that he was, "Always one number out." He then went on to consider why this was happening and realised that he was including the original number in his calculation instead of counting on. I believe that he is more likely to retain this than he

Immediate feedback from the software

would have done if I had told him where he was going wrong, a crucial step in self-assessment and taking responsibility for his own learning. This is evidence that the use of ICT can allow children to become more independent learners and for pupils to more easily compare and assess their own progress and learning.

The ICT activities were undertaken in a group situation. This can have both limitations and advantages. However, the use of ICT in the lesson was such that the children were so enthused by the activity that there was no evidence of distractions and, in fact, any evidence of interaction with peers was solely focused towards the task and ultimately the lesson objectives. Each child brought some contribution to the activity, they were taking turns as instructed, discussing ideas and overcoming difficulties as a group effort. However, although the nature of the software and the activity allowed for this, I still have concerns as to how much each individual was achieving. By giving the children the task of writing the extra line to the grid individually I sought to overcome this limitation as I was then able to assess the learning of each child.

The software, used positively, encouraged group discussion. As they had to interact with the software,

Group work

they were not mere objective observers. I made sure the activity was sufficiently complex and discouraged competitiveness and domination by one individual. They were sharing a "joint problem space", where "the participants used language and action to establish shared knowledge, to recognize divergence from that shared knowledge, and to rectify misunderstandings that impede work." (Underwood, 1998). However, I believe that, in the context of my lesson, the ICT needed to be supported with written work in order for me to ensure and assess the achievement of individuals.

There was evidence of peer group tutoring around the computers, in a marked difference from those working on paper. The children were working through their ideas, making suggestions, finding ways to overcome difficulties and discussing outcomes. However, in the groups around the computer, some became frustrated and even irritated when there was one child who needed longer thinking time. Others shouted out the answers and dominated the activity. Perhaps this was not the fault of the software but of my groupings. Something to be noted for review in the future.

The children were constantly under pressure from their peers to achieve quickly, especially when it determined the amount of time on the computer or whose turn it was to work on the computer. This is a direct consequence of the limited number of computers available in the average primary classroom.

Since the lesson was taken I have had doubts about how much knowledge has been retained. There is evidence now that the children have had difficulty in transferring their skills to a wider or real world context. A small proportion of children who had previously been

Peer learning

assessed as having met the objectives later struggled in this context. They seemed to have difficulty in creating their own number sequences using their own rules. They have since produced number sequences as a random set of numbers unrelated to each other. These same children have also shown difficulties in recognising missing numbers in a given sequence, a surprising occurrence in the light of the "Monty" software being based on this kind of activity. Perhaps the children were relying on the "guess" factor that the software allowed and therefore had in fact not fully understood the concept. So perhaps

I had initially over estimated what pupils had achieved or perhaps this demonstrates that children need exposure to these concepts more than once in different ways.

Using the software displayed on the large electronic interactive whiteboard was a very useful teaching tool. It enabled me to immediately focus all the children's attention at the outset of the lesson. Children are always enthusiastic and show heightened motivation when it is used in the classroom and in my experience it creates greater attention and enthusiasm to participate

Long term benefits

and respond. This was evident in the lesson. I was able to manipulate the software quickly and easily for demonstration whilst monitoring discipline, responses and understanding. It also meant that the questions became more effective as I was able to prompt discussion at appropriate times as 'Counter' was playing or whilst the 'Monty' game was playing.

I was therefore able to effectively use the ICT as a tool for instant differentiation. For example, the first group working on the computer were initially struggling with the task. I was able to quickly identify this and differentiate the task instantly by increasing the time to view the grid before it disappeared and by changing the grid to a simpler sequence. If the children were simply using a pre-prepared worksheet this kind of instant differentiation would not be possible. The children were therefore able to continue to work independently thus retaining a sense of achievement

The most useful and productive aspect of both the pieces of software is the fact that I was able to pose questions such as 'What would happen if ...?' This

Evaluating teaching using ICT

was extremely productive in extending the children's thinking. I was able to pose a problem to be investigated, prompt discussion through questioning and work with the children towards a solution. Once this interaction had occurred I was able to test the predictions without the tedious task of counting on numbers orally or on a number line. This also meant that I was able to work with more numbers and larger numbers, including negative numbers, than I would otherwise have been able to manage or demonstrate to the children.

Although the ICT was a useful teaching tool for the majority of the time, it was not without limitations. There were problems with the projector being 'knocked' slightly and therefore coming out of sync with the whiteboard. This meant that valuable learning

and teaching time was lost while I re-calibrated the screen and ultimately caused the children (and me) to fuss slightly

In conclusion, the use of ICT in the lesson was an invaluable teaching and learning tool. It enhanced motivation, enthusiasm and learning. However, it is important to remember that the use of ICT, especially the software, needs to be appropriate and matched directly to the learning objectives. The teacher and the children need to be confident in using the equipment and software and have the ability to overcome any difficulties. Finally, any assessment carried out needs to have the ICT taken into account to avoid any attainment being masked.

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References:

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