

Teaching and learning mathematics with an interactive whiteboard

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One of the aspects of my new job as Professional Officer for ATM that I enjoy the most is having more time than I had when I was a classroom teacher to think about effective ways of teaching mathematics. How much better everyone's teaching would be if they had more time to think and to prepare their lessons. Maybe pupils should do extra-curricular activities in the afternoons with people who are not teachers; this would free up teachers to prepare such good lessons for the next morning that pupils would learn just as much in two-thirds of the time. But this is another article!

What I want to write about now is how using interactive whiteboards changes what happens in mathematics classrooms. I have recently acquired my own mobile Smart board, which has helped me to start thinking about this. But it was visiting two schools in Birmingham that really persuaded me of the positive influence which this new piece of technology will have on mathematics teaching.

Micromath 18.2 contains two articles written by classroom teachers, Anne Richardson and Ruth Tanner, which discuss the impact of ICT on teaching and learning. Anne's article is about interactive whiteboards; Ruth's is about using a TV and one computer, which has many similarities to using an interactive whiteboard, in that the whole class and the teacher are paying attention to the same shared image. My recent experience of using an interactive whiteboard reminds me of the times, in the mid-eighties, when I regularly used one BBC 'B' computer and a large black-and-white monitor with my classes. I remember using FGP (SLIMWAM, ATM, 1982), Digame and Tilekit (SLIMWAM2, ATM, 1984), Factor (SMILE, 1984), Snook (Problems and patterns in Numbers, JMB/Shell Centre, 1984) and Plod (Teaching with a Micro, Shell Centre, 1986). I also remember why I chose these particular programs. They either helped me to teach a specific mathematical idea:

- Equations of straight lines (FGP)
- Probability (Digame)
- Angles in polygons (Tilekit)
- Factors (Factor)

or they provided a context for a piece of CSE coursework (Plod and Snook). Of course, the time I am writing about was before GCSE and there was no National Curriculum. Snook was part of a publication which came to be known fondly as 'the blue box', produced by JMB, now AQA, and the Shell Centre at Nottingham University, to support an O-level module that aimed to 'develop the performance of children in tackling mathematical problems of a more varied, more open and less standardised kind than is normal on present examination papers'. Unfortunately, eighteen years later, this aim is even more relevant and urgent.

So why am I talking about eighteen years ago? Because after that, I made much less use of one computer in the classroom. Why was this? Well, soon after that I stopped being Head of Mathematics and became a senior manager. This coincided with a change of emphasis in schools generally, away from one computer in the classroom and towards networked computer rooms. These had to be booked in advance for the whole lesson and their software consisted of office software such as Excel. I tried a few times to get to grips with Excel but found it difficult to use and was not convinced that my pupils would learn a great deal of mathematics from using it. Eventually - but it took me an embarrassingly large number of years - I did find uses for Excel. Meanwhile, I found that none of my favourite programs would run on the new computers, and in any case I did not want to use them in a room full of computers. And then the BBC 'B' computers began to go wrong and nobody knew how to mend them!

So, using my new Smart board, and visiting classrooms where teachers are regularly using interactive whiteboards have brought all these old memories flooding back. The most powerful memory only came back to me when I was in a classroom watching a teacher using a whiteboard and realising that it was as if the whiteboard was in control; the pupils were treating the teacher as another learner. Of course, this is an illusion: the teacher was still in control, because he had decided what the interactive whiteboard would display. But it was a useful illusion nevertheless and I found it exhilarating to watch.

I visited the classrooms of two teachers, in different schools in Birmingham, who are working towards an M.Phil. with Dave Hewitt and Pat Perks at Birmingham University. Each of the teachers' classrooms was fitted out with an interactive whiteboard and projector and the teachers were given a laptop and a range of appropriate software. This was funded by Birmingham LEA in one case and by a DfES Best Practice Research Scholarship in the other.

At Bartley Green Technology College, Dax Earles has warmly embraced the new technology. He has written a vast amount of his own material, some of which has now been published [1]. First I watched him teaching a Y9 top set. The lesson began with twelve miscellaneous revision questions. Because Dax had prepared these on his laptop the night before and then displayed them on the whiteboard, the presentation was very professional and the pace quick. He only had to tap on the board to get the next question, which meant that he could focus all his attention on the class. Then, when the pupils marked their work, the questions appeared again and another tap revealed the correct answer. What I particularly like about the programs Dax has written is that they make effective use of the interactivity of the whiteboard. In both the lessons I observed, he used the whiteboard for everything, even for taking the register and he does not even have a board for writing on or a flipchart in the room.

In the second lesson I observed, Dax was teaching a Y9 set 6 class. The lesson provided an introduction to the probability of combined events. The program Dax had produced 'threw' two dice and displayed them. The pupils wrote down eight numbers on their 'Bingo' cards and crossed one off each time it corresponded with the sum of the numbers thrown. This is an activity I have often used with my classes, but I threw two dice using a coffee mug and told pupils the sum of the numbers shown. I thought the activity was much more effective using Dax's program on the interactive whiteboard, because:

- Each total is displayed and kept on the whiteboard (up to a maximum of 24), so that pupils can see which scores come up and how frequently;
- The pupils can see the dice and they have to add up the numbers shown for themselves; so they cannot accuse the teacher of manipulating the results;
- The pace is much quicker, because the program generates a new throw more quickly than real dice could be thrown;
- As a consequence more games can be played in a lesson and pupils can observe similarities and differences in the sets of scores obtained.
- The teacher is able to concentrate all his attention on the pupils, because all he has to do is keep tapping the same point on the whiteboard.

I also visited Jonathan Mortimer's classroom at Hamstead Hall School in Handsworth Wood. He was teaching a Y9 set 3 class in which all pupils had just achieved a level 5 or 6 in their KS3 SATs. Jon began with three 'warm-up' activities. In the first activity, two-digit or three-digit numbers were randomly generated one at a time and displayed on the board and the pupils were asked by Jon to double or halve them. So the pupils had to both watch the board and listen to the teacher. The numbers changed very rapidly and the pupils were expected to call out the answers in chorus. You could hear when there were a significant number of incorrect responses; when this happened Jon would stop and go through the calculation. Again, the use of the board (which Jon only had to tap to bring up a new number) meant that it was easier for Jon to watch the class and spot anyone who was not participating. For the second activity Jon used a program written by Pat Perks [2], which displayed equations of the form $x + a = b$ and $ax = b$, where a and b were randomly generated integers.

Again I was struck by how a routine activity is enhanced by the use of the whiteboard, because the pace is so much faster, the material is well presented and the teacher's attention is focused on the pupils' responses rather than on thinking about and then writing the next question on the board. In this lesson, when several pupils called out a wrong answer, Jon switched the whiteboard to flipchart mode (which means that an electronic pen can 'write' on the whiteboard) and explained how to work out the solution to the equation.

In the final warm-up activity, which Jon wrote using Excel, a number grid was displayed, in which there were a lot of blanks. Enough cells were filled in to help the pupils deduce that the numbers in each row went down in threes starting from the left, and the numbers in each column went up in fives starting from the top. Jon would point to a blank cell and invite pupils to say what number should be in it. One click of the pen highlighted the cell and a second revealed the number. This is another activity I am familiar with, but it was so much more effective when done in this way. And obviously the teacher can change the way in which the grid is constructed.

The main part of the lesson was an introduction to graphs of quadratic functions, using Geometer's Sketchpad and some Excel files Jon had prepared. He was able to switch quickly between the graph-drawing program and the flipchart mode and he would use his electronic pen to show, after discussion with the pupils, how the graph produced by the program might change when the equation was changed. He was able to change the graph by, for example, moving an Excel slider button which changed the value of the parameters a and c in $y = ax^2 + c$. The moving image that this produced enabled pupils to see how changing different parameters changes the shape of the graph. Yet again, I was struck by how much ground can be covered in a short time.

Of course, the three lessons I observed had involved a lot of preparation beforehand. But all the material could be used again and by other teachers in the department. The lessons were of high quality and produced a positive pupil response. I spoke to some of the pupils and asked them what they thought about maths lessons now that they involved use of an interactive whiteboard.

It's easier to understand.

You can go back and look at something the teacher wrote on the board earlier in the lesson, because it has not been rubbed off. (Anything written in flipchart mode is automatically saved.)

It's way better & I am learning more.

The diagrams and graphs are good.

You can change the numbers quickly.

It's more advanced.

So the pupils already felt they were learning more and, from my limited observations, I agree that a lot was being

learned. I believe the use of interactive whiteboards in classrooms can influence the teaching and learning of mathematics because:

- one shared image in the classroom encourages discussion;
- the pace of the lesson is increased, because the teacher does not waste time thinking about the next question, writing it on the board, throwing dice, etc;
- it encourages teachers to plan lessons which involve interactive whole-class activities;
- some of the control in the classroom transfers from the teacher to the whiteboard and so the teacher can be perceived as a learner alongside the pupils;
- the teacher can look at the class, rather than at the computer keyboard (which would be the case if a computer and large monitor or image projected on to a wall were used);
- the teacher can concentrate on pupils' responses, because the program is driving the lesson;
- small programs can be written or bought to teach specific mathematical topics;
- numbers, diagrams and graphs can be changed quickly;
- dynamic images are readily available and can be amended using a pen or finger;
- it is easy to switch between different modes of use and different programs.

In my letter, published in *Micromath* 18.3, I proposed a way in which ATM can contribute to this exciting new development. This is to produce a CD of classroom activities for use with an interactive whiteboard. We can write some new programs and we might also update some of the wonderful programs in SLIMWAM and SLIMWAM2. These publications contained descriptions of a variety of lessons using the software. We would aim to do this and might be able to include video clips of the lessons. If you are interested in being involved in a working group to develop this publication please contact me.

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