The Interactive Whiteboard and the PGCE

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In this paper, we describe how we work with our PGCE student on the role of teaching and learning mathematics with interactive whiteboards. The course encourages students to develop materials in order to improve their expertise but also focuses on the pedagogical implications of this new technology.

Introduction and Rationale

In the light of the rapid increase in the number of interactive whiteboards (IAWs) in schools, those who prepare students for the classroom should endeavour to equip them with the requisite knowledge, skills and understanding in order for them to operate effectively and efficiently in front of pupils. We believe that the arrival of poorly equipped professionals in the classroom will not only mean that that resources and investment are wasted but also that the opportunity for growth and development will be lost.

Our research to date (see website address at the end) suggests that the nature of pedagogy in the future should change in order to meet the demands of the pupils, since they will require a more technological and sophisticated approach. As IAWs are being installed in schools at an ever increasing rate we, the teacher educators, face an increasing challenge to adapt our pedagogy in order to help our students maximise the potential of the IAW. In addition the market is providing more and more packages that are intended for use on IAWs, and that whilst some will help make a contribution to the learning process others will not.

With this in mind we devised a course focussed on the contribution of IAWs to the teaching and learning of mathematics. This course was to be taught on the first year of our two-year PGCE conversion course in mathematics. Our aims were to:

- define and demonstrate good practice in the use of the IAW;
- demonstrate, and provide workshop opportunities for, the development of resources for the IAW;
- demonstrate, and give an opportunity to work with, software packages on the IAW (e.g. Geometer's SketchPad/Cabri, Omnigraph/Autograph);
- provide an initial input into a pedagogy of IAW use;
ensure that students are proficient in its use by providing opportunities for them to present material to their peers using the IAW;

help them become aware of the IAW’s potential in dealing with classroom management;

help students become aware of the significant contribution that the IAW can make to learning;

develop a culture in which students might be made aware of the nature of research and academic writing that focuses on the use of the IAW in the mathematics classroom.

Hence the course was designed to give knowledge of theory, research and practice; training and practice in the skills of the IAW’s use and some understanding of why, how and when to use one. Furthermore, it is important to note that this has to be addressed in the context of the mathematics curriculum and in this sense has both discrete and diffuse aspects. In addition we would expect that our ‘tuition’ would demonstrate good practice and reflect all that the course sets out to achieve.

The course is delivered in 18 one-hour sessions and is complemented by an additional course that addresses key themes of the National Curriculum. Thus it is possible to present classroom material in context using the IAW.

In order to strengthen the course we made it so that assessment was centred on a small portfolio with direct reference to the aims. First, students are required to compose a Flipchart (the software available with the IAW we use) to deliver a National Curriculum topic and at the same time demonstrate the full range of IAW manipulations covered during the course. This Flipchart is then presented by the student to the rest of the group and is then the focus of discussion with them. A second part of the assessment is a report written – as if by a Head of Department to a Board of Governors – supporting an application for IAWs in a mathematics department. The report is required to give a discussion of the advantages of IAWs and the contribution they make to the teaching and learning of mathematics based on current research and evidence.

We now provide an example of one of the early sessions that attempts to give a flavour of the course. The session in question concerns the building and use of number pyramids in order to introduce algebra. This is a particularly useful topic in the context of the course since it forms the basis of the ArAl project (Malara and Navarra, 2003) and as such is well documented in terms of its pedagogy and its contribution towards learning. Further it is a technique suggested in the Framework (DfEE, 2001) and can be used as a source of interesting mathematics.

In what follows, the intention is to demonstrate how these aims and objectives are tackled in this particular session. In order to give a sense of the focus of
discussion during the session we have talked about tutor and student when describing the session itself and teacher and pupil when suggesting how the material is best used in the classroom.

**Define and demonstrate good practice in the use of the IAW**

The tutor presents material for the session through a Flipchart with a front Contents page which hyperlinks to each of the sections thus indicating what will be addressed during the session. This not only signals what will be covered during the session but also supports a considered structure. Typically we arrange that each session begins with a teaching situation likely to be found in the mathematics classroom. In this case the session begins with a demonstration of an elementary pyramid in which the number in each brick is equal to the sum of the two bricks immediately below it (see Figure 1).

![MINI PYRAMIDS 1](image)

Two bricks are placed next to each other and a third brick is placed on top as shown in the diagram.

Arrange the numbers given according to the rule that the upper brick contains the sum of the two lower bricks.

Is there more than one possible arrangement of the numbers?

In this situation the solution is restricted to the ‘13’ brick being placed on the top and the other two bricks being placed below (although there are two equal arrangements of this). However, to meet the objectives of the course, and emphasise good practice with the IAW, the point would be made that alternatives (and reasons for their dismissal) would be considered. In the mathematics classroom a teacher would expect pupils to be explicit about what was being attempted and explain why it would and would not be acceptable. Similarly, to help with the compilation of this and other similar flipchart pages, the tutor is able to discuss with students general presentation features: the fonts used, the colours used, the hyperlinks available, the white space available, the positioning of the text and the way the numbers are able to ‘fit’ into the bricks of the pyramid. Consideration of these and similar features are significant when considering best practice.

In this way and using a simple example, we believe that it is possible to replicate
good practice and identify the key features that support good pedagogy in using the IAW.

Figure 2: preparing the pyramid in Excel

Demonstrate, and provide workshop opportunities for, the development of resources for the IAW

A particular skill required by students is the ability to use the IAW, and its associated software, to organise and present material developed in other environments. Throughout the course we encourage the students to consider how a range of sources from Word through to the Internet might be used in this way. In this session, the tutor demonstrates how Excel can be used to construct both the pyramid templates (figure 2) and the number tiles. First the cells are sized to give reasonable bricks and tiles. In this case each cell is 50 pixels by 60 pixels. Then with the whole spreadsheet highlighted the background is made white (this removes the cell outlines), the cells are formatted for text (Arial 18, Bold and Centred with the required colour) and appropriate cells are merged to give the required pyramid structure. (In this case this means two cells are merged into one in appropriate places. It is also possible to simply copy and paste a merged double cell as required). These merged pyramid cells are then coloured and bordered as required, copied using the ‘camera’ facility of the Flipchart software and sent to the correct e-screen.

At this stage, when the picture is automatically pasted by the camera it is necessary to make the white parts of the transferred image transparent so that the white does not create layering problems later. With the elementary pyramid template now in place it is possible to make the required number tiles.

The tiles are made by a similar process to that of the pyramid (using the camera after creating the image in the Excel file). However, in this case it is necessary to copy only one ‘double cell’ at a time with the required number in place (so
that they can be used individually); for presentational effect, the cell sizes are reduced by 5 pixels in each direction in order that the tiles might fit in the pyramid template without ‘crossing’ the edges. In this example it is required to make three such number tiles that will fit into the pyramid as required.

When the number tiles have been transferred to the Flipchart and their position relative to the pyramid fixed, it is necessary to add any required text. This can be achieved in one of two ways. First, text can be added directly to the Flipchart using the Text Tool - elements of this are shown in Figure 3.

It is possible to format the nature, colour and style of the text by using the palette (and if required a virtual keyboard is available in most cases) and once completed the text can be positioned anywhere on the screen according to taste and requirements. Alternatively, text can be copied from another source (a Word document for example) and copied directly onto the Flipchart page via the Text Tool. As part of this course, presentational styles and effects are considered and discussed in detail. In fact students very quickly establish their own preferred style of presentation and this provides useful discussion points during the sessions.

This elementary technique of copying from one environment to another can be used to great effect across a range of software. By encouraging students to be creative in this way and respond to their work, the tutor is able to focus on the generalities of the process rather than specific content. We believe that being able to manipulate software in this way is an essential feature of best practice using the IAW.
Demonstrate, and give an opportunity to work with, software packages on the board (e.g. Geometer's SketchPad/Cabri, Omnigraph/Autograph)

Here the focus is on Excel. However, this technique of using e-screens from other sources and integrating them into a Flipchart is a powerful one and throughout the course a number of different software packages are used. In many cases the process is the same. The Flipchart is used to look at particular case and its tools are used to manipulate elements in such a way that promotes discussion and interaction. Here single cells with particular values can be moved around the e-screen with ease. When using this with pupils, teachers can clarify terms and rules before moving back into the original software to look at further and more general cases.

In the same way we use geometry programs and graphing packages and encourage the students to think carefully how they might be used to promote effective teaching and learning.

Provide an initial input into a pedagogy of IAW use

With the number tiles and elementary pyramid template now in place, it is possible to move the tiles into position. This is achieved by using drag and drop, a manipulation whereby the teacher in accordance with requirements positions e-screen elements (i.e. picks up the elements with the IAW’s equivalent of a mouse click, moves them to a new position with the equivalent of the mouse button still depressed, and then places the element in the desired position by releasing the equivalent of the mouse button). Here we see the manipulation used to place the tile in the pyramid. (The largest number must be placed in the top cell and the remaining tiles in the lower cells.)
Students are able to complete this first activity quickly and with ease though there is little scope for discussion about pedagogy and presentational style with this example. The use of colour sometimes is an issue and font style can be inappropriate on occasions. However, developing a Flipchart page with two such elementary pyramids (see Figure 4) where the sixth number tile contains an unknown number begins to demonstrate the potential of the IAW to support interactive teaching as well as lead towards the beginnings of algebra as demonstrated in the ArAl project. During the session students are asked to construct such a Flipchart and begin to consider how it is a next step in the search for algebra.

In this example the discussion with students focuses on how the teacher might manage the alternative solutions to the problem. As a first step pupils might be invited by the teacher to arrive at a solution by using drag and drop to place the tiles in a way that meets the requirements of the problem. Using the IAW allows pupils to correct ‘incorrect’ arrangements with ease thus removing any stress brought about by the need to be ‘right first time’. Tiles can simply be repositioned. In working with students, the tutor would emphasise the importance of asking children to explain their particular movement of the tiles as they are working with them. The link with language in this context is considered to be important from a learning point of view. Working with pupils, the next stage would be the exploration for alternative solutions. The first solution can be saved using the camera facility and a second, third, … solution obtained each requiring pupils to be creative, systematic and clear about their strategies.

In the session with students the focus is on process and interaction, the nature of questions and prompts, how and when to search for alternatives, promoting cognitive conflict, seeking justification and generalisation. These features lie at the centre of ‘enhanced interactivity’ (Miller et al., 2004). The IAW gives the opportunity to present and collect alternatives for discussion. Additional
manipulations such as hide and reveal (in which prepared solutions are shown to pupils after appropriate discussion) enhance the quality of the discussion and maintain pace and focus in the lesson.

Figure 6: using Excel to prepare solutions

At some stage in the process, it is likely that the tutor will move to an Excel spreadsheet in order to generate a number of pyramids quickly (see Figure 6). In the session with students, the tutor then invites them to develop further Flipchart pages that move towards elementary algebra and perhaps the solution of simple linear equations. They are encouraged to explore the richness of this format and approach by: increasing the number of layers in the pyramid; changing the position of the unknown within the pyramid and establishing generalisations about what is possible and what is not.

Later students would discuss how the use of such pyramid templates is managed in the ArAI project and in the Framework. This gives status and validity to the approach although in both these cases the material is used within a static as opposed to a dynamic environment. In addition two examples of such an activity, Pyramid numbers and Pyramid equations from EXP 7 could also be considered. This allows for a discussion of the advantages brought to the teaching and learning process by the IAW.

**Ensure that students are proficient in IAW use by providing opportunities for them to present material to their peers**

An important feature of our course is the encouragement and opportunity given to students to use the IAW to present material to their peers. In all sessions students are expected to come to the IAW and show features of their work. Without this experience we believe that students will not have the facility with the IAW’s tools to be proficient in the classroom. As part of the final assessment students have to compile a substantive Flipchart demonstrating the features of the IAW covered during the course and arrange for them to be used in a way to
show how pedagogy can be enhanced. Each student is then timetabled to present their Flipchart to the remainder of the group. At the end of the presentation there is a discussion of its features and how these support interactive teaching.

**Help them become aware of the IAW’s potential in dealing with classroom management and its significant contribution to learning**

The aim of the course is to expose pre-service teachers to the potential of the IAW to support and enhance teaching and learning in the classroom. This is achieved both by example and by specific reference. Such references will include:

- consideration of classroom layout and the relative positioning of IAW and desks;
- health and safety issues related to the use of the data projector;
- question and answer techniques to ensure an optimum level of interaction with all pupils;
- management of and advice to pupils working at the IAW;
- orchestration of activities to include pupils working at their desks as well as at the IAW;
- how the IAW might be used to support visual, audio and kinaesthetic learning;
- the use of multi-representations to support cognitive and concept development.

Such items are not always apparent to early users of the IAW who see it as something to be mastered only in a technological sense. However, as mathematics educators we believe that it is precisely these features of the use of the IAW that we need to be discussing with our students. The sessions, structured around particular topics of mathematics, provide the opportunities for them to be discussed and explored.

**Develop a culture in which students might be made aware of the nature of research and academic writing that focuses on the use of the IAW in the mathematics classroom**

In our view, it is important that we should establish clear links between what appears to be good practice in the classroom and what has been the finding of current research. To this end as part of the course students are asked to read both texts and research papers related to learning styles and the use of IAWs. Whilst there is opportunity to discuss what is written during the sessions, as part of the assessment of the course students are expected to justify the use of IAWs in school with reference to the latest publications. The results of our own recent
research are particularly relevant in this respect.

**Conclusion**

Although all these features are demonstrated using the IAW we would expect our students to prepare resources like these away from the IAW since it is much quicker. To this end we have been allowed to provide them all with the relevant software by the IAW manufacturers and have ensured that we have enough software licences and available machines to allow this to happen. We also provide opportunities for students to use the IAWs by making suitable rooms available on a regular basis.

Whilst our course seeks to equip students with the technical skills necessary to operate an IAW at an advanced level, we do not see it simply as a technical or skill based course. It is our belief that best practice in the mathematics classroom is built around properly managed and orchestrated pupil-pupil and pupil-teacher interaction. What we suggest in our course is that the IAW offers new and better opportunities for this interaction to take place effectively and efficiently and in our sessions we focus on examples of how this might happen. Throughout the course there is discussion of learning styles and appropriate pedagogy as well as resources and how to manage them. Our aim is that our students should know and understand what is meant by enhanced interactivity when working with the IAW and be well on the way to achieving this when they enter their first teaching post.

Currently we are in the second year of this course and continue to reflect on how it might be improved. We would welcome comments or advice from others.

**References and a selected bibliography**


Mathematics in Schools (2003 onward) a journal from the Mathematical Association
Micromath (2002-05) a journal from the Association of Teachers of Mathematics
Miller, D., Averis, D., Door, V., & Glover D. (2004) From technology to professional development: how can the use of an interactive whiteboard enhance the nature of teaching and learning in secondary mathematics and modern foreign languages? Unpublished report to the British Educational Communications and Technology Agency

**Recommended interactive whiteboard specific software**
EXP Maths 7, 8 and 9 from Nelson Thornes found at [http://www.nelsonthornes.com/secondary/maths/marketing/books_exp.htm](http://www.nelsonthornes.com/secondary/maths/marketing/books_exp.htm)
Interactive Teaching Programs (ITPs) from the DfES found at [http://www.standards.dfes.gov.uk/numeracy/publications/-Interactive-teaching-programs](http://www.standards.dfes.gov.uk/numeracy/publications/-Interactive-teaching-programs)
Interactive Mathematics from the Association of Teachers of Mathematics found at [http://www.atm.org.uk/buyonline/products/software/sof065.html](http://www.atm.org.uk/buyonline/products/software/sof065.html)
Advice for teachers of mathematics
Major sites of interactive whiteboard information for mathematics teachers
Keele interactive whiteboard site for teachers of secondary mathematics, research and resources found at [http://www.keele.ac.uk/depts/ed/iaw/](http://www.keele.ac.uk/depts/ed/iaw/)
Advice for those new to interactive whiteboards: The REVIEW Project found at [http://www.thereviewproject.org/index.htm](http://www.thereviewproject.org/index.htm)
Health and safety found at [http://www.becta.org.uk/leaders/leaders.cfm?section=3_1&id=3173](http://www.becta.org.uk/leaders/leaders.cfm?section=3_1&id=3173)

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