ENABLING ENHANCED MATHEMATICS TEACHING
WITH INTERACTIVE WHITEBOARDS

Final Report

for the

National Centre for Excellence
in the Teaching of Mathematics

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Enabling enhanced mathematics teaching with interactive whiteboards
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Executive summary

1. This interactive whiteboard (IWB) research was undertaken over two years by a team of teachers working with the Keele University interactive whiteboard team led by Dave Miller.

2. Our evidence is drawn from extensive and on-going literature searches, video recordings and direct observation of secondary mathematics teachers using IWBs and our wider working with schools over a three year period. This was supplemented by transcriptions of discussions (from our regular meetings) with the members of the research team using a Developmental Work Research approach.

3. All members involved in the research reported making considerable progress in terms of their own professional development.

4. Our video evidence suggested that most of the teachers making up our video sample, whether experienced users of IWBs or not, tended to ask low-level questions that in terms of Bloom’s taxonomy (1956) focus on only knowledge, comprehension and application. We saw little that offered pupils an opportunity for analysis, synthesis or evaluation – the higher level processes that society seems to be requiring of its workforce.

5. In addition we have brought into this work our experience in Initial Teacher Education, our regular teaching on IWB and Cognitive Acceleration in Mathematics Education professional development courses, the work on questioning by Watson and Mason (1998) and the work of Dalton and Smith, 1986, concerned with Bloom’s (1956) taxonomy.

6. In the secondary mathematics classroom we have therefore used and tested a pedagogy for the IWB that we have termed ‘at the board, on the desk, in the head’. This is an interactive way of working with the IWB so that all lesson activities are integrated into an interactive (rather than a didactic or presentational) whole and orchestrated/facilitated using the IWB software as the means of storing and organising all the electronic resources for the lesson. The report details underlying assumptions about the ‘look’ of such a mathematics classroom. A typical lesson will have pupils interacting with the teacher, the IWB and with each other and would involve some of the similar features found in lessons that are typified by the approach of Swan (2005) and by the Improving Learning in Mathematics materials found at http://www.ncetm.org.uk/Default.aspx?page=13&module=res&mode=100&resid=1442.

7. We have incorporated some exemplar material at www.iwbmathstraining.co.uk and colleagues can add to this as they develop materials. We will be continuing to add materials to this website over the next few years. In addition a Mathemapedia entry for this approach can be found at: http://www.ncetm.org.uk/mathemapedia/BoardDeskHead

8. We would support the comment from the recent OfSTED report Mathematics: understanding the score (paragraph 57) that more curricular and guidance documents should draw attention to the potential of IWBs. In addition, in terms of teacher workload, the agencies involved in producing such documents should provide IWB-ready materials rather than expect teachers to produce versions for themselves (and for this to be replicated in schools all over the country).

9. We have devised a diagnostic questionnaire that teachers can take to help them answer the question “How interactive are your lessons?”

10. We recognise that teachers need continuing professional development in order to enhance their teaching of mathematics with an IWB and have created a framework to support the development of interactivity. We would recommend that this framework is followed by teachers working in pairs (or as a department). This SPORE (Skills, Pedagogy, Opportunity, Reflection and Evolution) framework to interactivity considers the technological Skills of the teacher (in creating for and using resources at the IWB); sees those skills used with an appropriate Pedagogy (such as ‘at the board, on the desk, in the head’) that includes appropriate higher-level questioning (e.g. in terms of...
Bloom’s taxonomy); this provides an Opportunity for the teacher to use the IWB in a variety of interesting and creative ways and in so doing create (new) opportunities for pupils: Reflection on the teaching, pupils’ activities and learning then follows such use; finally, as a consequence, Evolution takes place as the teachers (and pupils) adapt and move on –around the SPORE cycle.

11. There is evidence to suggest that many ‘practical’ problems still need to be solved in mathematics classrooms relating to IWB use. These include positioning; lighting arrangements; ICT arrangements in schools that allow mathematics departments to access electronic mathematics resources that they want to use; and effective systems to share electronic materials (with both other staff and pupils).

12. Our evidence suggests that for a variety of reasons, including the piecemeal introduction of IWB technology into schools and the lack of continuing professional development, too often the IWB is being used for presentational purposes, showing mathematics as a set of rules, theorems or ideas that need to be demonstrated before pupils complete exercises. This use is typical in some of the popular IWB commercial materials – thereby reinforcing the presentational rather than the pedagogical advantages of the IWB.

13. As a consequence there is a need for a further range of IWB resources to be developed that reflect the nature of interactivity. These materials should be developed to offer, for example, practical activities together with a variety of ‘interesting’, ‘enthusing’ and/or inspirational starting points with indications of the way in which they might be used, and include direct links to further internet sources and the New Mathematics Curriculum for 2008 onward.

14. The IWB still has the potential to transform mathematics teaching, and in many cases it clearly has done this. It is our view that the level of support needed to enable mathematics teachers to develop an appropriate mathematics IWB pedagogy has been greatly under-estimated.

15. The introduction of the new mathematics curriculum, the abolition of the KS3 tests and the introduction of the Bowland maths activities may mean that mathematics teachers are looking to develop their mathematics pedagogy. We need to make sure that this opportunity is not lost and work systematically to see that teachers are provided with IWB materials that allow for enhanced interactive use.

16. We can no longer accept the assumption that simply placing an IWB in a secondary mathematics classroom will produce improved results in mathematics. As with a lot of technology the ‘Conscious Competence’ ladder (through lack of professional development) will mean that a number of mathematics teachers are not aware of what is possible in terms of enhanced interactive teaching with an IWB.

17. To help support such enhanced interactive teaching we have made ‘conservative’ suggestions about should be included, as a minimum, in a typical secondary mathematics classroom (see Appendix 4).

18. We have also put together a minimum set of software that we believe secondary mathematics teachers could use to help support pupils’ learning of mathematics (see Appendix 5).

19. The National Centre for the Excellence in the Teaching of Mathematics has a role to play working with relevant bodies to ensure that secondary mathematics teachers are provided with professional development opportunities that allow them to use an IWB in an enhanced interactive way.

20. We will be looking to continue and extend our work developing interesting and exciting ideas of our own as well as looking to encourage others to provide IWB ready materials that allow teachers to operate in a way that is fit for purpose for the pupils of the twenty-first century.

21. This Final report can be found at: http://www.keele.ac.uk/depts/ed/iaw/docs/ncetmreport.pdf
Context

This research was undertaken by a mixed team over eighteen months where some team members were experienced researchers into IWB use, some were experienced in delivering IWB professional development, (some were both) and the others used IWBs for virtually all their teaching.

The aim of this development-led research was to help mathematics teachers, both those new to interactive whiteboards and those who are not enhanced and/or interactive users, to adapt their pedagogy in order to ensure that pupils’ learning is enhanced. The intention was to create, trial and finalise a set of materials and resources, including a CPD framework, that would be usable as a stand-alone resource to help mathematics departments and individual teachers develop and adapt their pedagogy in order that IWBs might be used more effectively and efficiently by more secondary mathematics teachers.

Our earlier work and that of others has shown that use of the IWB in the classroom appears to have brought some improvements to mathematics teaching, but that this had not necessarily led to changes in pedagogy or to considerable improvements in pupils’ understanding (e.g. Moss et al., 2007, and Miller & Glover, 2006). Our evidence from detailed observations of teaching in seven secondary schools (Miller & Glover, 2006) had suggested that many IWBs are used more for their presentational impact rather than for their interactivity. We also note the report from the General Teaching Council of England (GTC), 2008 and the OfSTED report (OfSTED, 2008) that seem to be reporting similar things.

Evidence has been collected by and from the team and from our observations (direct or video) in the many schools that we have worked with over a number of years. Our sample is not random, neither was it selected to be representative of the secondary mathematics sector, however we believe that what we have found is not untypical – hence the authors’ decision to produce this report in this particular format.

The team

The team from Keele University (Dave Miller, Doug Averis and Derek Glover) was supplemented by two teams of teachers. Initially there were 6 team members who, by chance, happened to be using the same make of IWB. Later another team of 3 teachers was established who used the other main make of IWB (this came about from a training course run at Keele), however after the first meeting of this second team, it was decided that all teachers should be in one group to ensure that findings and materials would be of value to all teachers. The team had a mixture of experience both in terms of teaching and working with IWBs and computer software. Team members and affiliations:

Andrew Holmes, John Taylor High School
Camilla James, Tarporley High School
Dave Harrington, Walton High School
Dave Miller, Keele University
Derek Glover, Keele University
Doug Averis, Keele University
Fran Wilson, Parkside Federation
Kathryn Moore, All Hallows Catholic College
Mark McCourt, Harry Carlton School
Russell Harris, St Thomas More Catholic College
Sam Buckle, Queensmead School
Simon Curzon, Alsager School
Susan Cubbon, St Albans High School for Girls
Methodology

The work was built on and extended some of the IWB work already undertaken at Keele. It involved a detailed analysis of a small number of video recordings of mathematics lessons taught by new and inexperienced users of interactive whiteboards (these had already been looked at in a different way for two earlier projects). We also collected video recording of the initial group of teachers and used a small number of videos that we had subsequently collected from another school. The analysis was undertaken by the Keele team using a structured analysis framework.

The developmental-led nature of this work has meant that the Keele team has also supported and considered the progress of themselves and the rest of the team - collecting evidence in their roles both as teachers and as ‘IWB trainers’. We have also brought into this work all the visits to and classroom observations made in schools by the Keele team over the last three years.

In addition we have undertaken an extensive examination of the research literature (e.g. Miller and Glover, 2008, Higgins et al., 2007) and added to these data information collected from many other discussions we have had with others associated with secondary mathematics teaching including teachers in training, mathematics teachers, mentors, teacher trainers, National Strategy Mathematics Consultants and local authority advisers. Although it might be argued that this is body of evidence is largely anecdotal in nature it does allow us, in our view, to situate our work in the wider mathematical arena and is, we believe, reasonably typical of what is happening more widely in secondary mathematics in terms of IWB use.

We have worked using an approach known as Developmental Work Research that brings together university and school teaching staff in a non-threatening situation. This approach was developed by Engestrom (1987, 1999, 2001). The initial meeting followed the Tuckman (1965) pattern of behaviour with later meetings following the six stage approach suggested by Leadbetter et al. (2007). This has promoted a ‘team’ approach with considerable gains for the participants. We followed a structure of reporting on progress, developments since the previous meeting, individual findings and then reflection on materials and their use and their relationship to the new secondary mathematics curriculum (of September 2008).

There were seven one day meetings, roughly one a term, of the first group - the last three were attended by the second group as well. The purpose of the meetings was to build on the video evidence using the experience of the individuals in the group (including the Keele team) in developing their IWB practice. The focus of the days was to look at both mathematical and IWB activities used by members of the group and to attempt to begin to analyse these in terms of the key features of such activities in order that we might arrive at a framework for an appropriate pedagogy for IWB use in secondary mathematics. The analysis of the video recorded lessons also helped to inform the development of this framework. This process involved a cycle of activity, discussion, reflection and tasks that extended the work for all the team members beyond the meeting days. Meeting minutes were taken and discussed at the next meeting. At each meeting team members brought along more activities that were shared and/or shown, discussed, used by others back in school to help inform the next meeting. Three of the participants said that they were now using this structure in their departmental work in their schools.
The evidence brought to these meetings included comments on video recordings, reflections on training sessions run by course members (whether in school, locally or nationally), discussions about other teachers’ use of IWBs and consideration of an appropriate IWB pedagogy based on individual and collective experience related to the evidence available.

Tasks were set between meetings (e.g. video record yourself – after meeting one) and team members also agreed to work with other members of their department in order that they might also benefit from the research. The successes (and failures) of this were also fed back to the group and this also helped our work progress and the development of our ideas.

During the research we gained a separate contract to provide IWB development for the Secondary National Strategy and we offered 7 Introductory and 7 Advanced Courses for National Strategy Mathematics Consultants nationwide, with roughly two thirds of the Consultants attending one or more of the development days. These took place in December 2007/January 2008 and March 2008 - so the timing worked well with our timetable with time in between the courses to adapt things. Most members of the team managed to attend at least one of these days to support the work and it gave us a good trial of our ideas and materials – which have subsequently been adapted following this process – resulting in a later finish to the project than we had anticipated.

Outcomes

All members of the team reported making considerable personal progress in terms of their own professional development and from the Keele perspective we believe that we have improved the skills experience and pedagogical understanding of our PGCE students, with impact on teachers on other courses that we have delivered. In addition the team members report that they believe that their departments have also benefited from the research and their involvement. (See also Appendix 1.)

However our wider work with schools has reinforced the findings from our previous research that teachers are often reticent to develop their skills in the use of IWB to support mathematical learning. Often they feel that they must make use of IWBs but do so using presentation software (OfSTED, 2008) such as PowerPoint or ‘textbook on the computer’ approaches which lead to regression to didactic teaching, thereby, in part, negating some of the positive potential of the IWB (and we suggest that this might, in some part, explain why there appears, as yet in research studies available, to be little impact on attainment in mathematics). Once given confidence through the availability of appropriate materials, CPD and technological support within their schools, teachers are willing to explore new approaches and begin to think of approaches that enhance interactivity.

The outcomes are structured as follows:

A pedagogy for interactive whiteboard use
- Questioning and working at the ‘analysis’ level of Bloom’s taxonomy
- At the board, on the desk, in the head

Interactive whiteboard website, materials and resources
- IWBMathsTraining website
- Lesson management
- Improving Learning in Mathematics resource
- Resources for IWB use
A pedagogy for interactive whiteboard use

The work of the Keele team over a number of years has been leading us to establish this pedagogy which has been influenced by our work in Initial Teacher Education (ITE) and in CPD where we have worked with over 500 teachers or trainee teachers on interactive whiteboard use over the last 6 years and, in addition to that, over 80 mathematics departments in the last 9 years on our two year Cognitive Acceleration in Mathematics Education course (see for example Adey, P. & Shayer, M., 1994).

Questioning and working at the ‘analysis’ level of Bloom’s taxonomy

We have also been influenced by Bloom’s taxonomy (1956), the work on questioning by Watson and Mason (1998), our re-analysis of the sample of video recordings of mathematics lessons and the analysis of the videos of research team members at work.

Our video evidence suggested that most teachers in our sample tended to ask low-level questions that focus, in terms of Bloom’s taxonomy, on only knowledge, comprehension and application. We saw little that offered pupils an opportunity for analysis, synthesis or evaluation – the higher level processes that society seems to be requiring of its workforce. We therefore adapted the work of Dalton and Smith, 1986, by extending their exemplification of and question cues for the taxonomy into the mathematical domain. Here we show our first attempt at a mathematical ‘version’ of analysis:

**ANALYSIS**

Is: seeing patterns, organisation of parts, recognition of hidden meanings, identification of components

**Question Cues**

analyse, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer

We have established an interactive way of working with the IWB that proposes a cycle of learning opportunities, integrating the learning process so that activities might start from work on the IWB (i.e. at the board) or from a desk-based activity (on the desk) or from a concept, idea or learning objective (in the head). The essential feature is that these activities are carefully integrated into an interactive whole.
There is an assumption that

- the mathematics classroom is a collaborative classroom where pupils regularly work in groups (not just pairs) and discuss their mathematical experiences
- lessons are interesting and motivational (more than just colourful) and involve pupils in mathematical thought and discussion rather than consisting of exposition, example and exercise – it is not enough just to do well in examinations and tests
- the ‘at the board, in the head, at the desk’ activities are fully integrated
- all electronic resources and links are stored with the IWB software file
- questioning begins at Bloom’s analysis level (using for example “What can you see?”) rather than at the knowledge level
- wherever possible work is targeted at Bloom’s higher levels
- activities at the board will often involve the use of ‘virtual manipulatives’ used in an exploratory way - a virtual manipulative is, for example, an onscreen version of a graphic calculator, geoboard, protractor, fraction wall (there are many of these available from the Internet)
- the use of the ‘virtual manipulative’ by the teacher does not replace the use of real manipulatives by pupils, but complements their use
- teaching will involve a variety of approaches that will cater for all learning styles (although we do not necessarily accept theories about such learning styles we recognise that the IWB allows a variety of approaches including visual, oral and kinaesthetic)
- the IWB software allows for a variety of means of interaction (e.g. drag and drop, hide and reveal etc.) that can (and should) be used in innovative and imaginative ways
- linear presentations (as often seen in PowerPoints) are not the best way to prepare for such lessons as they constrain the teacher to demonstrate and display rather than use other means
- mathematics lessons are not about exposition, example and exercise

Furthermore we believe that it possible to adapt and enhance many of the materials currently available in other forms (e.g. texts, worksheets and packages). With some additional work it is possible to retain the content and thrust of such material but widen the impact by adding the opportunity for this pedagogical approach (at the board, on the desk, in the head). Such adaptations have already been undertaken with the material developed in the ‘Improving Learning in Mathematics’ resource (see later).

Use of this pedagogy might also help solve the problem referred to in paragraph 58 in the recent OfSTED report (OfSTED, 2008) which states:

A negative effect of interactive whiteboards was a reduction in pupils’ use of practical equipment: software is no replacement for hands-on experience, for example in measuring angles and lengths. Teachers generally underused practical resources and games to develop pupils’ understanding of mathematical ideas and help them to make connections between different topics.

Information is also found in the Mathemapedia entry ‘At the board, on
Interactive whiteboard website, materials and resources
IWBMathsTraining website
There is one new website arising from this research: www.iwbmathstraining.co.uk.

It contains information and lessons that might be of interest to secondary mathematics teachers who use an IWB when teaching mathematics. The site contains:

- links to training materials from the two main IWB manufacturers
- training materials for use with ACTIVstudio version 3 (Promethean) and Notebook version 10 (Smart)
- a list of introductory and advanced IWB skills (Promethean and Smart) with links to training materials for these skills – these have been separated into those we consider one needs for teaching and those one needs for preparing resources
- IWB files (Promethean and Smart) that will support an ‘on the board, at the desk, in the head’ pedagogy – all of which have been acknowledged and accepted by a member of the team
- IWB files (Promethean and Smart) for all the Improving Learning in Mathematics lessons – since we believe that these exemplify good practice and it should not be up to individual schools to create IWB files
- IWB files (Promethean and Smart) that may or may not have teacher notes that come from a variety of sources – the National Strategies: Secondary, Thinking through mathematics, Bowland maths, members of the research team etc.
- our specification for a mathematics classroom of the beginning of the twenty-first century
- our top ten mathematics websites
- links to research about IWBs
- link to the Mathemapedia entry ‘at the board, on the desk, in the head’
- full and summary report of the NCETM funded research Enabling enhanced mathematics teaching with interactive whiteboards as well as links to other work arising from this research

This website www.iwbmathstraining.co.uk will be maintained up until 2010 and is expected to remain in place for several years after that. The intention is to continue adding materials added to the site. It will be fully operational from 1 January 2008, though a trial version is already in place.

Lesson management
Teaching colleagues have argued that whilst they appreciate the potential of the IWB they are inhibited by the time needed to develop resources. Almost all of our IWB files for Promethean and Smart boards contain the additional electronic resources required for any given lesson (wherever this is reasonable in terms of file size and allowable in terms of copyright). In most cases any files and Internet links required either during a lesson or for preparation have been stored (embedded) in the files so the user needs only to find the main lesson file to have everything (electronic) for the
lesson. This aspect of ‘portability’ does not provide the required computer software programs but only the files (e.g. word processor or pdf documents, spreadsheet files, dynamic geometry files for use with dynamic geometry programs) and will only play flash files or java applets if the necessary software has been installed on the computer.

Having all the files stored in one single file improves lesson transitions – this is possible with both the Promethean and the Smart software. Also, and importantly, the files from the latest versions of the software of these two IWBs can be transferred from one format to the other, with most information correctly transferred across (an advantage for teachers moving schools).

**Improving Learning in Mathematics resource**

We believe that the lessons provided in the Improving Learning in Mathematics resource (sometimes referred to as the Standards Box) exemplify good practice and we have therefore adapted all of these lessons for use with the two most popular IWBs in secondary mathematics classrooms. Our way of doing this has involved taking all the pupil materials from the lesson plans and creating them as IWB pages so that they might be used to help supplement, amongst other things, the discussion of the mathematics during these lessons. In effect we have created cut-out and moveable versions of cards that are intended to be used on pupils’ desks. These files are meant to supplement rather than provide an alternative way of using the original materials. These files are freely available on the IWBMathsTraining website so that other teachers who want to use them do not have to spend time creating similar materials.

**Resources for IWB use**

A number of agencies, institutions and other bodies regularly produce resources for use by mathematics teachers (National Strategies, NCETM, DCSF, Bowland Maths) and these often consist of pdf resource files which may contain lesson plans and lesson materials. However they rarely contain IWB versions of the materials. This means that many teachers have to spend time creating very similar sets of materials based on the same sets of resources (or do not bother). In an electronic age when we are concerned about teacher workload this ought to be changed so that IWB resources are made available at the same time (at least for the two main IWBs currently in use in mathematics classrooms). This might help solve part of the problem noted in the OfSTED report (OfSTED, 2008) paragraph 57.
How interactive are your lessons?

As a final part of the work it was decided that there would be a diagnostic questionnaire on the website that might provoke thought about interactive teaching and what it entails. This tool is designed to raise questions in the mind of those who take it, to provide us with on-going evidence though, in reality, it gives our view on what we see as the key features of an interactive lesson with an IWB. The questions can be found at www.iwbmathstraining.co.uk

Professional development

Skills, Pedagogy, Opportunity, Reflection and Evolution (SPORE): a framework for professional development

Central to effective use of the IWB is sustained appropriate CPD. We believe that our SPORE model provides an appropriate framework for such CPD and we believe that this framework may be more widely applicable for mathematics CPD. However here we develop the framework in terms of IWB use.

SKILLS

Here we are concerned with the skills associated with IWB use and these are defined as those technical skills required to use the full range of features offered by the IWB and its associated software. Entry level skills are loosely defined as those skills which enable a user to switch on the IWB, align it correctly and use the elementary tools such as pen and straight line functions. Higher level skills are those linked to more sophisticated functions and usually require more stages of development before they are in place. We believe that many of the skills of using the IWB are essentially simple in character, but their creative use and as a consequence their effect on the e-screen, in the context of the lesson, can be quite startling and thus have a considerable effect on the success of the lesson.

PEDAGOGY

Here pedagogy is connected with the art and science of teaching and in particular with the development of an IWB pedagogy and our notion of ‘at the board, on the desk, in the head’. To this end we are involved with the practical nature of planning and preparing lessons, taking note of styles of teaching and models of learning. However integral to this and the use of the IWB is our focus on the nature and level of questioning, pupil-teacher-pupil interaction, creativity and the establishment and culture of a learning community. Using the IWB is not just about using ‘flashy’ techniques but rather about how the totality of the experience for pupils. In our view we cannot emphasise enough the importance of the nature of the task and the questioning in use by the teacher.

OPPORTUNITY

In our terms the skills and pedagogy provide the opportunity for the teacher to use the IWB in a variety of interesting and creative ways, some of which might not be possible without the IWB. Our focus is therefore not only upon the mathematics but also upon the way in which it might be approached. In using the IWB in these ways the IWB also provides the opportunity for pupils to learn, in our view, in more appropriate ways through their increased involvement with, for example, discussion and activities rather than listening and completing numerous exercises. The IWB is more than the sum of its parts: it is more than just an elaborate presentation device that allows mathematical or IWB software to display accurately mathematical explanations, exercises and practice examples that can be worked through and placed on a virtual learning environment (VLE) for pupils to use in their own time.

REFLECTION

This is the process in which the teacher engages after the classroom experience to focus on aspects of the use of the IWB and the effects of the pedagogical approach taken by the teacher.
and how it has impacted, positively or negatively, on the teaching, pupils, their learning or work habits. It may lead to 'discomfort' initially as pupils, especially older ones, might react to new ways of learning. Whilst reflection can be a solo affair, we believe that this process is more effective and powerful when carried out with a colleague. Clearly, in our view, the more informed, or the more 'in-tune', the colleague is in relation to the use of the IWB, the more effective the reflection. We believe that it might help the process of the reflection if teachers also reflect on the creativity evident in the lesson. The ability to recall material from a succession of screens as discussion develops is a significant aid to supporting the development of the habit of reflection.

EVOLUTION
Evolution occurs as a result of the classroom experience and the constructive reflection. Effective use of the IWB does not happen instantly, it comes through sustained use and development, serendipitous activity (sometimes in the classroom when something unexpected happens) or through contact/discussion with others. It will involve some of the elements noted above and is likely to include gradual modification and improvements to both sophisticated use of IWB tools and software along with enhancement of pedagogy in the light of what has happened in the classroom.

We believe that as part of this evolution creativity can improve with confidence and experience, as it is a personal quality that could be usefully ‘evolved’.

The ‘Conscious Competence’ ladder
Our experience suggests that for many early users and for those teachers who have been given limited access to professional development that it is likely that ‘they do not know what they do not know’ - i.e. in terms of the ‘Conscious Competence’ ladder usually attributed to Dubin (1962) they are ‘unconsciously incompetent’. As a consequence such a teacher may continue to work in the same way until something, such as professional development causes them to realise that more might be possible - at which stage they become ‘consciously incompetent’. Further CPD, in terms of skills and pedagogy, might lead them to become ‘consciously competent’, and then after the opportunity for classroom use and reflection on this use might come evolution where they become ‘unconsciously competent’. There is no doubt that this process takes time.

Thus it may be beneficial to a mathematics department to allow teachers to attend CPD on IWB use or to allow staff to work with other more informed staff so that they might further develop their practice using the SPORE framework for professional development.

The mathematics classroom
In finalising our work the Keele team considered how the IWB should form part of the complete mathematics classroom and to this extent looked at what else one might want to have in a well equipped mathematics classroom. We based this on our discussions with and observations of the many teachers we have worked with in the last two years on research projects, professional development and through our initial teacher education work.

We have put our thoughts under these two headings.

- Essential equipment and features of the mathematics classroom
- Highly desirable features

The detail of this can be found in Appendix 4.
Essential software for secondary mathematics teachers

In considering how the effective mathematics classroom might be organised and managed with regard to the use of ICT in lessons, we also put together our list of essential software, much of which is free, all of which can be found by an internet search. We offer this as our starting place and to raise awareness of what is around and in use in some schools. The detail of this can be found in Appendix 5.

However no matter what software base is available the ICT structure within the school needs to be such that it does not create barriers for use – this seems to be an increasing problem in schools as schools look for complete systems (integrating information, curriculum and assessment) across schools.

Implications for further development

We have been surprised over the time of the project (and before this as well) with the number of schools where equipment has been bought with apparently little attention paid to the positioning of the IWB, provision of regular (or in some places any) CPD, and ICT support issues of a technical and software nature. We have therefore put together this list as we realise that despite earlier work, e.g. Miller and Glover (2006), Moss et al. (2007) much still needs to be done to help many mathematics teachers make more effective use of IWBs in their classrooms.

There have been problems with the installation of expensive equipment in a piecemeal way as funds have become available. Our evidence is that consideration should be given to the location of the IWB within the room (to use established patterns of room organisation may be detrimental), so that visibility is maximised, light interference minimised and access to electrical points arranged so that health and safety concerns are addressed. We found that pupils generally need to be organised so that at times they are facing the IWB (so that ‘at he board’ is the focus for this part of the lesson) and at other times they are working in groups (‘at the desk’ is the focus of this part of the lesson). Beyond this it is necessary for computers to be networked to allow for the use of shared resources.

We note in particular the reports of Moss et al. (2007) and OfSTED (2008) – the former noting that learning gains could not be found as a consequence of IWB use in mathematics and the latter showing that the quality of teaching and learning in mathematics in schools was considered to be outstanding or good in 54% of the schools surveyed.

Issues that need to be addressed for too many secondary mathematics teachers include:

- appropriate positioning of the IWB so that teachers can get to it properly and so that it can be seen at all times of the day by all pupils in the class
- putting in place simple systems to allow software to be put onto computers and updated as required (especially the IWB software and flash and java applications) – in some cases even having access to mathematics software
- having a simple department or school structured system that allows colleagues to benefit from the work of others – e.g. an appropriate way of sharing electronic resources created by members of the department with a common understanding of file naming (many schools now
offer this through a virtual learning environment (VLE) but these are not always simple to learn how to use

- reducing time spent by teachers replicating the work of others (e.g. National Strategies: Secondary producing IWB ready materials) - this is why we have done this for the Improving Learning in Mathematics resource files (and will do it for other resources)
- using an appropriate pedagogy for mathematics teaching with an IWB – such as ‘at the board, on the desk, in the head’ and all that it entails
- access to professional development following, for example, the SPORE framework in relation to IWB use, ideally this will have whole departments working together, but failing this it is an advantage to have at least two members of staff working together
- access to professional development in the use of ICT packages especially geometry programs but also graphing programs and spreadsheets
- becoming aware of the ways in which other technology, especially the use of tablet PCs, individual pupil ‘slates’, and voting systems can add to the range of opportunities for involvement, assessment and the development of mathematical understanding
- the provision and use of graphic calculators for pupils from an early age.

The role of the National Centre for Excellence in the Teaching of Mathematics

Many of the issues outlined above are issues of policy and strategy at both national and local level or are not easily solved by mathematics teachers working within their own environment.

We would therefore urge the NCETM to consider working with other relevant bodies such as headteacher organisations, initial teacher educators, mathematics subject associations, the National Strategies, and the Specialist Schools and Academies Trust to:

- increase awareness of the potential of the IWB to support ‘enhanced interactive teaching’
- enable the distribution of this report and the resources developed in this research so that they can support teachers who wish to use IWBs in an enhanced way.
- foster a national drive to secure CPD in the use of IWB technology as an integral element of effective classroom practice – making use of appropriate resources
- develop appropriate IWB resources that might exemplify such practice

Conclusion and next steps

In many ways this is an important time for mathematics teaching. This autumn term has seen the introduction of the new mathematics curriculum with its emphasis on key concepts, key processes, the range and content and curriculum opportunities. The Bowland materials are also available at Key Stage 3 and provide excellent opportunities for pupil to work in different ways. We have received the observations of OfSTED (2008) in the recent publication Mathematics: understanding the score where the question “What does good or outstanding teaching look like?” provides us with the OfSTED view of such teaching:
13. The best teaching was rooted in developing pupils’ understanding of key concepts. It was inclusive in terms of ensuring that all pupils made substantial progress, no matter what their starting points. In the outstanding lessons, the teachers had high expectations of pupils’ enjoyment and achievement. They made conscious efforts to foster a spirit of enquiry, developing pupils’ reasoning skills through approaches that saw problem-solving and investigation as integral to learning mathematics. They checked that everyone was challenged to think hard and they adapted how they were teaching to achieve this. As a result, their classrooms were vibrant places of learning.

14. In the most effective lessons, teachers often presented new topics by challenging pupils to apply their mathematics to solve problems, drawing ideas from them and using probing questions to gauge their initial understanding and develop it. They sequenced learning carefully, helping pupils to make links to related areas of mathematics. They used visual aids and demonstrated ways of thinking that helped pupils to understand the methods they were learning and to overcome common misconceptions. The teachers listened to pupils carefully and observed their work throughout the lesson. They aimed to identify any potential misconceptions or barriers to understanding key concepts, and responded accordingly. They also emphasised the development and accurate use of technical language.

We believe that the use of the IWB as described in this report can help increase the number of good and outstanding lessons (with an assumption by all of us, including OFSTED, that this will lead to improved attainment). Our earlier report for the Secondary National Strategy (Miller & Glover, 2006) showed that in many ways the IWB made a difference – but we now need to make sure that this difference leads to more effective use of the IWBs and that this brings about not only an improved classroom culture where pupils enjoy and understand mathematics but also an improvement in pupils’ results and a desire by more of them to follow mathematics through post-16 and post-18.

We will therefore be looking to continue and extend our work developing interesting and exciting ideas of our own as well as looking to encourage others to provide IWB ready materials that allow teachers to operate in a way that is fit for purpose for the pupils of the twenty-first century.

**Evaluation**

The research was evaluated by Jenny Piggott, NRICH (and now also NCETM). She attended some of the meetings and was sent minutes for others. Her report is attached as an appendix and her participation in meetings helped us to redefine our working practices and to focus on realistic outcomes.

**Thanks**

The authors and team would like to thank the National Centre for Excellence in the Teaching of Mathematics for their support, the schools of the teachers in the research for allowing them to take part, Jenny Piggott for her evaluation and all others who have made a contribution.

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http://www.dfes.gov.uk/research/data/uploadfiles/RR816.pdf


Appendix 1: Evaluation Report for the NCETM Funded Interactive Whiteboard Project in Collaboration with Keele University

Report by Dr J S Piggott BSc, PGCE, BA, MSc, MA (University of Cambridge)

1. **Introduction**
The project involves three major outcomes:
- The impact on, and professional development of colleagues directly involved in the project
- The production of web and CD-based materials for sharing with the wider community
- The offer of professional development courses for less-experienced and more-experienced teachers.

This evaluation report focuses on the first of these outcomes.

2. **Methods**
This evaluation is based on meetings with the project leader, a meeting of the development group, attendance at a training day and questionnaires sent to each member of the group. The interim report is included as appendix 1.

Members of the development group included colleagues from the University of Keele as well as from a wide geographic area.

The evaluation looked at how the personal/collaborative aspects of the project affected those involved and perceived notions on the impact of the project on the wider community.

3. **Overview**
The project delivered successfully in all areas of its proposal. The focus of the project leader on identifying key products of the project (such as the CDs and development days) helped to maintain a momentum throughout the project. One of the most valuable aspects for the NCETM was the ability of the project leader to draw in resources from other areas to support and extend the project in related and mutually supportive ways.

For teachers and HEI colleagues directly involved in the project development, a most valued aspect of the project was being given time to work with other teachers with a range of expertise. There was some evidence that the involvement of a University and NCETM gave the project status within some of the schools. The University worked as a hub for this project and potential to make connections with research and educational developments more generally. This was seen by all as a very valuable aspect of the project by all involved. From the point of view of colleagues within the HEI, the role of teachers was felt to be crucial in making outcomes realistic and based on classroom experiences.

Even within the small community involved in developing the project, some colleagues found it easier to take their findings back into school and influence change than others. It is interesting to reflect on where a fairly intensive involvement worked effectively and where it didn’t. If people intensively involved in such projects feel their impact is limited what are the likelihoods of other less intensive inputs making a significant change? In the particular case in point the colleague did not have a senior management role within their department and this could be a key factor. This has implications for the likely impact of the more “remote” aspects of this, and similar, projects where the outcomes are disseminated through mechanisms such as the production of CDs and the offer of short (one day) training opportunities.

4. **Outcomes**
4.1 **Personal/collaborative aspects of being involved in the project.**
All teachers involved in the development group found the time to think and share with other colleagues very important and at the heart of what was an effective professional development experience for them. The focus on an area of mutual interest was valued as well as the opportunity to share ideas and develop in confidence and, in some cases revitalise views of teaching.
"I have been privileged to work with this group – they have shown the reality of effective CPD"

"This has given me far more belief in myself; what I thought was good practice and an important way to develop my teaching"

"it’s [the project] helped me stay positive about the job generally."

The partnership between schools and an HEI was generally seen as important, with three main reasons clearly articulated. Firstly, getting the commitment of the school:

"Basing the project in an institute of higher education, and knowing it was commissioned by NCETM, has given weight to my involvement. My school have been happy to release me as the project is seen to be ‘proper’"

Secondly, to give the potential for research to impact on practice:

"The University as a hub and potential to make connections with research and educational developments more generally."

Thirdly, to influence research practice:

"We value the work we do with colleagues from schools and needed their classroom input – my observation is in general rather than mathematical fields but I noticed the progression of colleagues towards understanding newer pedagogies"

4.2 Aspects of professional practice

In identifying aspects of professional practice, colleagues raised themes around, organisational issues, effective use of resources, technical issues and pedagogy. In discussions changes in, and development of, pedagogic approaches was rated as highly important.

"As we discussed these methods, we naturally discussed how it might be used and would affect learning. The pedagogy of learning maths was more subtle in discussions and mostly based on the impact of interaction. This was understood and widely acknowledged by all."

However, it is interesting to note that responses in the questionnaires often made limited reference to specific examples of “pedagogic shifts” and this was only achieved by refocusing of questions four or five times. For example, questions such as “Can you give an example(s) of how the project has helped you to use the IWB more effectively/efficiently” elicited only technical responses. Whilst some examples can be given I am not convinced that this fully reflects the pedagogic impact of the project and more detailed research would be needed to make this clearer.

4.2.1 Organisational issues

These included the use of the whiteboard software to record lessons for future use. For example, to share with absent pupils, or as a resource for pupils working independently:

"This means absent pupils can be given a copy. … I have also provided a copy of files to one pupil working independently”

Or as a focus for personal reflection and development:

“I review what is saved, edit and improve and ‘go again’.”

4.2.2 Pedagogic Issues

Shifts in practice ranged from the use of particular interactive software to the use of the board more generally. For example:

“A session using the Nrich interactive geoboard was very effective with Year 7 for assessing their knowledge of triangles and encouraging them to investigate."

and

“Greater use of “reflective” material. Pupils discussing results, and ideas.”

In the first example it is the particular piece of software that resulted in a shift in the second the implication is taken that a range of software offers opportunities to discuss results

More general comments included

“greater emphasis of ‘on the desk/ at the board’ activities.”

An approach to effective use of the IWB emphasised by the project leader and picked up by a teacher.
And
"..., they are using it as a tool to help explain there reasoning. It is not just MY board but the belongs to the whole class."

Reflecting how the use of the board in general has affected practice.

4.2.3 Purpose
Colleagues were aware of, and emphasised in various ways, their view that the IWB was not the answer but that the purpose of its use was at the heart of the project:
"it is not an effective tool without the mathematical purpose being clear."
"it is the move from what we use to why and how we use it"

5. Potential impact
In this section I will briefly discuss the project team’s view of the potential impact of the project, personally, locally and in the wider community. This is the main insight into the potential for such projects to have an effective and lasting impact on practice more widely.

5.1 The range of audience
Colleagues identified aspects of how they developed practice at three levels. In school, locally and nationally. In school this included informal support for colleagues, sharing practice through department meetings, working with other departments and through whole school development programmes. One school built in performance targets based on their involvement in this project.

Local inputs included heads of department days and local teacher networks and colleagues referred to the IWB courses at a national level. These aspects were seen, not only as developing the practice of other colleagues but also personally empowering. Colleagues described their experiences of positive feedback from sessions they had run, requests for support as well as a sense that they could pass on, at some level, their own enthusiasm.

5.2 The timeliness of the Project
Nationally, participants drew particular attention to the timeliness of the project, fitting in well with the changes to the National Curriculum (NC) though with an awareness that a connection needs to be made for teachers. Of particular importance was the sense of the pedagogic opportunities offered by the IWB and how this meshed with the new emphasis on Key Processes:

"Linked to the Key Processes, this may provide a change in attitude towards the IWB- A tool to promote discussion and learning, rather than just a “demonstrator” of skills."

"In light of the new NC many departments are being asked to examine their beliefs about teaching and learning and to move away from more using exposition. … In terms of moving pedagogy forward, I think that the impact of what happens at the board is generally overlooked and I hope that by focusing part of the materials on the ‘at the board’ objectives that this, alongside Dave’s research, will get people thinking about how what happens at the board is helping learning to take place. “

5.3 Issues related to impact
Descriptions of input often started from the technical and moved into the pedagogic. There was a sense that as level of technical competence was needed by teachers before any pedagogic shift was likely to happen.

"Hopefully, the current trend for the IWB simply to be a fancy “chalkboard” will be changed. Teachers will come to see how the dynamic nature of software can be used to promote discussion in the classroom and enhance the learning experience. “

It is this balance that may prove challenging at a level where input is not face to face.
"the new NC may give teachers a reason to look at the materials and thus I hope that they will be used to inform creative, interactive learning through exploration and discussion. It’s hard to see,
though, how this will be likely without somebody pushing the materials to schools in this way. … If
the advisors/consultants then push the materials for in house training and offer training
themselves (raising the issue of pedagogy) then I can see it could be really useful. I know the
teachers that I’ve been working with would like the CD and have already taken lots of examples
from me to work on.”

Some caution was expressed concerning the ability to maintain impetus (in this case in one of the project
team’s own school):

“Initially it [impact] was quite high and everyone was keen to use the board and pen more. The drive
seems to have been lost over the year though under the weight of everything else particularly exam
season (which is now Jan through to June) and only the most enthusiastic and conscientious are still
producing resources. I think it will pick up again towards the end of this term …”

6. Conclusion
The project was managed to a very high standard and was excellent value for money. One reason of the
value of the project was the director’s efforts to seek funding from other sources to support the core
funding where he saw the project would benefit from development beyond the initial brief. It was the
holistic, joined up approach adopted by the project leader that resulted in extensive outcomes. For
example securing the opportunity to offer professional development to National Strategy consultants.

Careful consideration needs to be given by the NCETM to the dissemination of projects such as these. A
highly significant aspect is the development of the individuals involved and the question is how much of
this can begin to be shared with the wider community and have an impact on practice.
Appendix 2: Other Articles and Reports Related to the Research

How can we use interactive whiteboards effectively for mathematics learning?
Fran Wilson (Parkside Community College) and Any Holmes (John Taylor High School)
Webpage of the article: http://www.ncetm.org.uk/Default.aspx?page=41&module=research&researchid=10289

See pages 2 and 3 of the Teacher Enquiry Bulletin found at:

Enabling enhanced mathematics teaching with interactive whiteboards
Fran Wilson (Parkside Community College) and Dave Miller (Keele University)


We would expect this to be available by following Teacher Research Conference 2008 at:
http://www.standards.dfes.gov.uk/ntrp/
Appendix 3: Mathemapedia for BoardDeskHead

At the board, on the desk, in the head
Using the interactive whiteboard to enhance mathematics teaching

The interactive whiteboard has the potential to transform learning and attainment, but so far this has not yet happened (or the evidence is not available to show that this has happened). It has transformed some teacher’s teaching, improved the presentation of mathematics in classrooms and motivated learners throughout the world. But what about the holy grail of improved results linked directly to interactive whiteboard use? Is it impossible to measure? This Mathemapedia entry considers one way to use the interactive whiteboard as a planning, organising and pedagogical tool that might help improve learning.

Full entry found at: http://www.ncetm.org.uk/mathemapedia/BoardDeskHead
Appendix 4: The mathematics classroom

In finalising our work the Keele team considered how the IWB should form part of the complete mathematics classroom and to this extent looked at what else one might want to have in a well equipped mathematics classroom. We based this on our discussions with and observations of the many teachers we have worked with in the last three years.

Essential equipment and features of the mathematics classroom

It is surprising how many mathematics classrooms with an IWB in it have problems in relation to the first two bullet points below:

- at least one non-mobile interactive whiteboard (with a suitably bright data projector) arranged in a position so there is easy access to it (either side) with a suitably fast Internet connected computer/laptop (with speed to play DVDs properly), a quick simple printer and speakers, with appropriate blinds/curtains so that the display can be seen all day and all year
- software can be easily added/updated on the IWB and all school computers
- software (for use on interactive whiteboard, teacher's and pupils' computers, including home use) as detailed below
- all pupils having their own graphic calculator (e.g. bought for them and loaned to them in year 7) – one of the makes that can be used in external calculator papers
- wireless laptop computers (there are now several that can be bought for less than £200) for at least one between two with some technical support so that use of these is not difficult
- classroom set of mini-whiteboards; and assorted practical equipment such as geoboards; reaction timers; multilink or cubes, (e.g. 1000); ATM mats; normal dice (e.g. 200); assorted other dice; pairs of compasses; protractors etc.
- paper to include tracing paper, variety of squared, dotted, isometric, 100 square, coloured, display, A3 and larger blank etc.
- access to local maps thorough your geography department (the Ordnance Survey has given sets of these to most schools)
- ‘historical’ items (modern versions) such as abaci, log tables, Napier’s bones, old calculators, slide rules
- subject association materials that you consider useful
- mathematical books, games, posters, for pupils and staff to use
- practical equipment (e.g. assorted measuring devices etc.)
- at least one digital camera with a large memory card (e.g. 2GB which is very cheap)
- set of voting systems
- intranet system so that pupils might use lesson materials about the school or from home (with a simple means of arranging this e.g. through a virtual learning environment, VLE)

Highly desirable features

These are elements that would seem to be things that might make mathematics lessons more interesting and allow for more creativity in the classroom. They perhaps should be essential features of a classroom but we have not completely assumed unlimited costs.

- digital cameras, classroom set for one between two (in the department) – though mobile phones can be used in this way
- web-camera or visualiser to show pupils’ work on the interactive whiteboard
- voice recorders (to create podcasts) – set in the department
- at least one video camera to create animations and videos
- a second IWB

Future developments

We are already aware of mathematics classrooms where these things are beginning to happen.

- animation and video creation
- mobile phone use within mathematics lessons (most have a calculator, camera and many a sound recorder)
- podcasts and software appropriate for this
- web2.0 applications such as Second life or Facebook
Appendix 5: Essential software for secondary mathematics teachers

In considering how the mathematics classroom functions we also put together our list of essential software, much of which is free (indicated by * below), all of which can be found by an internet search.

Essential software for teachers (in alphabetical order where * indicates from Internet)
This is based on a PC but most have equivalents available for a MAC.

- acrobat reader* to read pdf files
- adobe (or another) SVG viewer* to view population pyramids
- Bowland mathematics materials (from DVD or Internet, but latter will take much longer to install)
- digital image manipulator such as picasa*
- drawing program for mathematical diagrams, equation-editor for writing equations in a word processor such as FX-maths pack
- EXP Maths 7, 8 and 9 (short programs that cover most of KS3 material)
- Flash*, java*, shockwave* that allow applets and internet-based programs to be used on the computer (free, but need to be installed and regularly up-dated)
- Formulator Tarsia* to create and use your own ‘jigsaws’
- Free Mind* ‘mapping’ software to be used for topic and lesson planning (from National Curriculum website)
- geometry program such as Geometer's SketchPad, Cabri-géomètre or Geogebra*
- Google earth*
- graph drawing package such as Omnigraph, Autograph, Geogebra*
- graphic calculator emulator to match graphic calculators in use
- interactive whiteboard software (free with interactive whiteboard)
- Internet browser (plus anti-virus, firewall, anti-spy-ware software)
- Mathematica player* to run Wolfram demonstration project files
- media player such as Real player*, windows media player* to play video clips from Teachers.TV or YouTube
- sound and audio editor such as audacity*
- spreadsheet such as Excel, Geogebra* (available 2009) or Open Office*
- Testbase for assessment examples (similar for GCSE and A level)
- Teacher tube* access
- Teachers.TV access
- virtual manipulatives (these are usually Flash programs and java applets that can be accessed from the internet, with the reference to the program or applet stored in the IWB file)
- word processor such as Word or Open Office*
- YouTube* access

Note that video retrieval websites such as Teacher tube and YouTube are not allowed routinely in many schools, however we are aware that a number of schools allow (some) staff access to these websites so that they can use worthwhile material (though it is possible to download relevant files and play them through a media player).

It is also possible that some mathematics departments might want pupils to make use of programming software such as Flash (which is not free if you want to have pupils use it), Logo (there are a variety of variations some of which are free) and others – one of the research team had pupils using Flash in this way.
Appendix 6: Top ten internet websites for secondary mathematics

Here is our selection of the top ten internet websites (in alphabetical order).

**curriculum.qca.org.uk/key-stages-3-and-4/subjects/mathematics/index.aspx**
The website for the new national curriculum of 2008. The aims for this new curriculum ‘… should inform all aspects of curriculum planning and teaching and learning at whole-school and subject levels. The curriculum should enable all young people to become: successful learners who enjoy learning, make progress and achieve; confident individuals who are able to live safe, healthy and fulfilling lives and responsible citizens who make a positive contribution to society.’

**nrich.maths.org**
Essential site that ‘… supports teachers and learners of mathematics with thousands of free resources which are designed to develop subject content knowledge and problem-solving and thinking skills. We aim to offer engaging and challenging problems, articles and interactive environments that offer opportunities for exploration.’

**www.bowlandmaths.org.uk**
Materials that ‘…look very different from most maths teaching materials. They consist of innovative case study problems, each taking 3-5 lessons, designed to develop thinking, reasoning and problem solving skills – as in the revised Key Stage 3 curriculum. Each case study is different, but all provide pupils and teachers with problems that are fun and engaging, while also being a rich maths experience.’

**www.itemaths.org.uk**
TDA commissioned Subject Resource Network for initial teacher educators but within this site contains links to most of the main mathematics organisations (subject associations, government agencies etc.) that have an interest and are involved in policy and strategy concerned with mathematics teaching and learning. Also contains resources that are helpful for those involved in initial teacher education.

**www.iwbmaths.co.uk**
Most of this advert-free site is free. It has pages that change daily, weekly or monthly. A subscription section (£50 a year for a school) has ICT training part and an interactive file section that links to over 800 interactive ‘virtual manipulatives’ that are usefully indexed by mathematics topic.

**www.iwbmathstraining.co.uk**
A free, advert-free site that has ideas and files for use with ACTIVstudio and Smart notebook software, training materials and interactive whiteboard versions for all the ‘Improving Learning in Mathematics’ topics developed by the Standards Unit as part of the Maths4Life project. The site is constantly being updated as part of Keele University’s work on IWB materials.

**www.ncetm.org.uk**
Portal for the National Centre for Excellence in the Teaching that ‘ … provides effective strategic leadership for mathematics-specific CPD. It aims to raise the professional status of all those engaged in the teaching of mathematics so that the mathematical potential of learners will be fully realised.’ Has links for research, mathematics self-evaluation, courses and a Mathemapedia.

These are the websites for the two major interactive whiteboard currently in use in the UK. Each provide information about upgrades, training materials (not necessarily easily found) and downloads of resources (of variable quality). Very useful as a means of keeping up to date.

**http://demonstrations.wolfram.com/**
Website that contains hundreds of interactive, open-code Demonstrations--created solely in Mathematica by users from around the world. The “Wolfram Demonstrations Project brings to life ideas in math, science, and many other areas, from elementary education to front-line research”. You can download all demonstrations and use with the free Mathematica player (must install on your computer).

**www.standards.dcsf.gov.uk/secondary/framework/maths/fwsm**
This website is where you find the ‘… renewed Framework builds on the original Framework for teaching mathematics, which was produced in 2001. It is based on the programmes of study for the new secondary curriculum. The Framework is designed to increase pupils’ access to excellent teaching and engaging, purposeful learning that will enable them to make good progress through Key Stages 3 and 4.’