# Interactive Whiteboards in Education

## Target audience

This briefing has been prepared for senior managers in further and higher education with responsibility for curriculum development and delivery strategies. It will be useful for assistant, deputy, and vice-principals, pro-vice-chancellors and heads or directors of Teaching and Learning. It aims to inform senior decision makers about the potential capability of a range of products called 'interactive whiteboards'.

## What are interactive whiteboards?

There are two very different kinds of interactive whiteboards:

The first is a 'virtual' electronic version of a dry-wipe board on a computer that enables learners in a virtual classroom to view what an instructor, presenter or fellow learner writes or draws. It is also called an electronic whiteboard and can be found in conferencing and data-sharing systems such as Microsoft NetMeeting. The second type is a large physical display panel that can function as an ordinary whiteboard, a projector screen, an electronic copy board or as a computer projector screen on which the computer image can be controlled by touching or writing on the surface of the panel instead of using a mouse or keyboard. This briefing is about the second type of interactive whiteboard.

Typically, interactive whiteboards are used in lecture or classroom environments and the technology allows you to write or draw on the surface, print off the image, save it to computer or distribute it over a network. You can also project a computer screen image onto the surface of the whiteboard and then either control the application by touching the board directly or by using a special pen. The computer image can be annotated or drawn over and the annotations saved to disc or sent by email to others.

## What are the benefits?

- Because interactive whiteboards are so like conventional whiteboards, they can help even technophobic teachers to use this medium with ease for presentations from the front of the room.
- They help in broadening the use of e-learning because they rapidly demonstrate the potential of alternative modes of delivery.
- They make it easy for teachers to enhance presentation content by easily integrating a wide range of material into a lesson, such as a picture from the internet, a graph from a spreadsheet or text from a Microsoft Word file, in addition to student and teacher annotations on these objects.
- They allow teachers to create easily and rapidly customised learning objects from a range of existing content and to adapt it to the needs of the class in real time.
- They allow learners to absorb information more easily.
- They allow learners to participate in group discussions by freeing them from note-taking.
- They allow learners to work collaboratively around a shared task or work area.
- When fully integrated into a VLE (virtual learning environment) and learning object repository there is potential for widespread sharing of resources.
- When used for interactive testing of understanding for the entire class, they can rapidly provide learner feedback.

## What are the disadvantages?

- Interactive whiteboards are more expensive than conventional whiteboards or projector and screen combinations.
- Their surface can become damaged, necessitating expensive replacement.
- Front projection boards can be obscured by one or more users.
- Fixed-height boards are often mounted too high for users to reach the top of or too low to be readily visible by all users.
- Free-standing boards (and their associated projectors) are more difficult to secure and need to be realigned every time they are moved.
- If multiple data entry is allowed, inputs can get jumbled, resulting in on-screen gibberish.
- If remote access is allowed, some users may be tempted to send disruptive comments or drawings to the screen.

## How do they work?

Fully-functioning interactive whiteboards usually comprise four components: a computer, a projector, appropriate software and the display panel. The computer is connected to the projector and whiteboard. The projector displays the computer screen image onto the board. Action on the surface of the display panel is communicated with the computer over a cable or wireless connection and interpreted via the installed software. Display panels can be either front or back projection. Additional components are available for some systems, including hand-held key pads for gathering individual responses and interactive white board tablets: in effect a small personal version of the larger board.

Some systems employ plasma screens instead of a projector, but they are very expensive and are therefore not considered further here.

There are three different kinds of interactive whiteboard technologies:

### Resistive Membrane

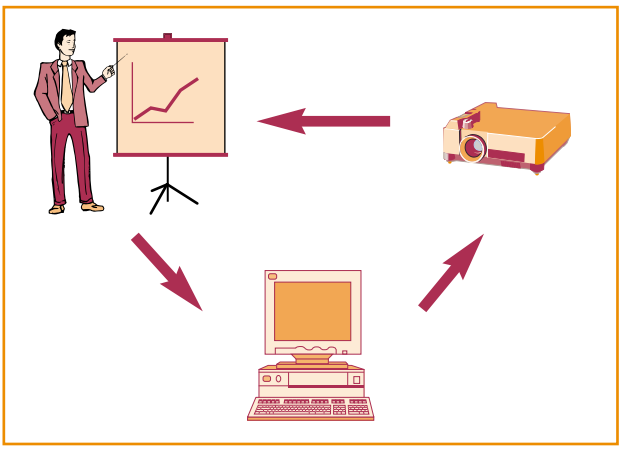
These whiteboards have a soft, flexible surface similar to vinyl consisting of two pieces of resistive material separated by a small gap which creates a touch-sensitive membrane. They can be drawn on using fingers or a special stylus that can represent pens of different colours via software selection. Movement is tracked by detecting the pressure of the stylus object on the surface. The co-ordinates correspond to the area on the computer monitor.

### Electro-Magnetic

These whiteboards are similar to traditional whiteboards in that they have a hard surface and can be drawn on with normal pens. To work interactively they require special battery-driven pens that emit a small magnetic field detected either by the frame of the whiteboard or by a grid of fine wires embedded beneath the surface of the board.

### Laser Scanners

These whiteboards have a hard writing surface with infrared laser scanners mounted in the top corners of the board that detect pen movement. To work interactively they require special felt pens, each of which has a uniquely encoded reflective collar that the lasers use to register its colour and position.



## When will they arrive?

Interactive Whiteboards are already available and in use in UK schools, colleges and universities.

## Where and how are they being used?

They are being used extensively in UK schools and in further and higher education. While they are less common in further and higher education institutions, where they are most often used by teacher training departments, there are some instances of their use across most discipline groupings.

They can be used to:

- Write over the top of programmes to highlight and annotate points.
- View and navigate the Internet from the whiteboard. Surf and display websites that the entire room will be able to see in a teacher-directed manner.
- Promote group working. Students can approach the whiteboard and add their contribution to the discussion by writing directly on the whiteboard. Groups can view and solve interactive problems together.
- Work collaboratively on word processing documents, spreadsheets, design projects with colleagues.
- Connect to video conferencing systems.
- Allow staff or students or both to move around a screen without the use of a computer because the screen itself is sensitive.
- Offer the same features as a traditional whiteboard such as writing directly on the board, marking objects, highlighting or labelling elements on the screen, and erasing errors but with the ability to save or print out the results without any additional effort.
- Offer an on-screen keyboard that floats over the software, allowing you to enter text or data into almost any application.
- Enable editing on-screen and recording of changes or additions.
- Provide an electronic flipchart (up to 99 pages), with all notes and diagrams saved as an HTML file for later use across an Intranet, allowing an archive to be easily maintained and displayed.
- Allow notes to be stored and made available to students who missed the presentation or lecture.
- Present student work to a wide audience.
- Show video clips that explain difficult concepts (in any curricular area).
- Demonstrate how an educational software programme works, e.g., an art programme with students using their fingers and hands to draw rather than working with a mouse.
- Cater more effectively for visually-impaired students and other students with special needs, using, for example, drag and drop exercises with graphics instead of text to test learning.
- Create drawings, notes and concept maps in class time which can be saved for future reference or issued as instant handouts for the lesson you have just given.
- Allow the tutor to monitor or see what each student has on their screen and choose which screen to display on the whiteboard in a networked environment.
- Run on-line tests and opinion polls and display instant feedback to the group.

Not all interactive whiteboards offer all the above features.

## What are the issues?

### Technical

There are two main technical issues: image resolution and tracking capability. High resolution aids handwriting recognition (1000 lines per inch resolution results in extremely good recognition of handwriting). High tracking speed means that writing and drawings appear on the screen virtually as they are executed. Lower tracking speeds delay execution which can be disconcerting. A tracking speed of 200 inches per second is sufficient for most applications.

### Functionality

Not all interactive whiteboard software packages offer the same functions. You need to check if a particular product allows users to:

- Draw or write on the board using different coloured pens or even fingers.
- Print out or save the results to the computer.
- Use advanced letter recognition systems that convert handwriting to text that can be edited.
- Support remote voting or feedback.
- Store sequences of screens for playback.
- Control computer applications via the screen interface.
- Customise the screen appearance.

### Accessibility

The large scale of interactive whiteboard panels and the option to control them and write on them using fingers make them potentially useful assistive devices for a range of visual and physical impairments. Moreover, synchronised software and the ability to work with all programmes on the PC has huge potential for blind students and tutors. Interactive whiteboards are also extremely useful in teaching hearing-impaired students.

### Security and convenience

Interactive whiteboards can be fixed or free-standing. Free-standing boards have the advantage of portability, but the disadvantage of being vulnerable to theft, together with their associated projectors, so additional security measures may be necessary. Fixed boards can be made more secure but they are less flexible to use. Portable boards can be moved around between teaching areas but must be aligned carefully with the projector each time they are set up and this can be inconvenient.

### Cost

Generally speaking, the higher the resolution and the faster the tracking speed, the more the board will cost. Prices as of the third quarter 2002 range from around £750 to £1600, depending on the technology employed and the size of the board.

The least expensive whiteboards are dual membrane resistive boards which can be operated with a fingertip or special stylus. Soft dual membranes are easily damaged however, compared with other types of surface and so replacement costs need to be factored in. You also have to train users NOT to use ordinary white board markers on them!

More expensive are the solid-state impact-resistant whiteboards that can be operated only with an electronic pen or a more expensive variant, offering control via a cordless infrared pen, A5 or A6 pads, or both.

Most expensive are the laser scanner whiteboards, operated by markers with special reflective collars.

Software is almost always included in the purchase price of the whiteboard but it is necessary to ascertain what the software does, as different packages offer different functions.

The special pens required by some boards range in price from around £5 to £120 each.

If the institution does not already have a digital projector, this has to be added in. Projectors cost approximately £2000, depending on resolution, brightness and size, plus £200 per bulb.

### Standards

Interactive whiteboards will work with PCs and Macs (but check you have the right software). Typically, they support a wide range of common resolutions, including VGA, XGA, SVGA, and SXGA.

### Pedagogical

Interactive whiteboards can be used as primarily presentation devices, but in that case you should consider whether a desktop or notebook PC attached to a data projector would do as well at rather less cost. The key pedagogic aspects of interactive whiteboards are:

Their size, which facilitates collaborative group working.

Their interactivity, which facilitates active learning, not just passive reception of information.

Their accessibility, for learners with visual or physical impairment.

Their recordability, so that an end product can be emailed, stored for subsequent re-use, or deconstructed to analyse a process.

## Alternatives

There are several alternatives worth considering, which are detailed below.

### Whiteboard conversion kits

A clip-on conversion kit for existing whiteboards allows the board to become an electronic copy-board (for example, Mimio: www.mimio.com or eBeam: www.e-beam.com). The clip-on device is linked to the laptop and can detect the movement of a dry marker pen (inside a special case) on the surface of the whiteboard. These kits use ultrasonic signals or radio waves to locate the marker and eraser. A battery-powered ultrasound mouse pen makes the whiteboard interactive. At around £350 these kits (plus projector and screen) are much cheaper than full interactive whiteboards and more portable, but they do not reliably pick up every stroke of the pen. So some lettering can be incomplete, which may be critical in spelling names and terms, or in mathematical formulae.

### Wireless keyboards

Wireless keyboards can be used to control a PC, so they could be used to drive a PC-data projector combination to give some of the functionality of an interactive white board, although without a stylus the option of writing or drawing on the screen is lacking. Two types are available. The cheapest is the radio frequency keyboard with a built-in trackball or separate infrared mouse at around £100. More expensive is the radio frequency remote keyboard and 'gyro' mouse at around £400. A gyro mouse is hand-held remote control which tracks hand motion and relays it to the on-screen cursor.

### Wireless graphics pads

Wireless graphics pads are small portable panels that can be written or drawn on with an electronic pen. Unlike tablet PCs or interactive white board tablets (see below), the image does not appear on the pad. It is sent to the projection screen only. Left and right 'mouse' buttons on the pen can be used to control Windows applications. Wireless graphics pads cost around £600.

### Tablet PCs

Tablet PCs are laptop PCs without a keyboard. Interaction is via the screen using a stylus. They can be connected to a network via a cable or a wireless LAN card and from there to a data

projector. At around £800, a networked tablet PC linked to a data projector is a cheaper alternative to an interactive whiteboard. It can be passed around between participants for individual contributions, but cannot be used as a group input device in the same way as an interactive whiteboard. The handwriting recognition software for tablet PCs is not as well developed as that for interactive whiteboards and currently, it is not fully embedded into applications. (One must use pop-up windows instead.)

### Interactive whiteboard tablets

These are small-scale interactive white board screens which work in much the same way as a tablet PC but with the benefit of pre-installed interactive white board software. At around £2000, an interactive white board tablet is an expensive option although it can be used to drive a large lecture theatre screen or to pass around among a group of users.

## How might they affect further and higher education in the UK?

Interactive whiteboards create a range of learning opportunities for both students and teachers. Studies have found them to be highly motivating and learner-centred when integrated innovatively. They offer a powerful facility for integrating media elements into teaching to enhance content and support collaborative learning. The drawback is that they may not be used to their full potential, serving in many cases as little more than a glorified whiteboard. This may change as users become more familiar with them and are more readily available.

They are ideal for small group, collaborative work, where several people can cluster around the board and interact with it as they develop ideas, work with an application or deconstruct an image. However in larger groups there may be problems associated with height and positioning. To be used interactively, the board has to be low enough for all parts of it to be within reach. This often mean that it must positioned so low that users in the back of a room without ranked seating cannot see the whole board. Some boards have portable pads that can be used as remote controls to overcome this problem, but this adds to the cost.

Other solutions to the line-of-sight difficulty are tablet PCs connected to a data projector aimed at a conventional whiteboard or screen, interactive white board tablets, wireless graphics pads or wireless keyboards. These devices allow the board to be positioned high enough to be viewed by all users and the device to be passed around to users. These options are generally cheaper than an interactive whiteboard and offer greater flexibility of use. The disadvantage is that having to take turns at using the device inhibits the spontaneity of group working. It is possible to overcome this by using more than one device, but this would increase costs significantly.

On balance we believe that interactive whiteboards, where the user interacts directly with the surface, are a technology worth investing in now, wherever the investment costs can be justified for small group working. On their own, they are not such a good investment for working with large groups because of the limited opportunities for interaction within large groups. However, they can be supplemented with a range of hand-held devices which extend their usability in large groups. It seems likely that they will have a significant role to play in further education colleges, where they are already well established. Market penetration in higher education is lower and may be overtaken by lower cost and more flexible alternatives or both. An exception to this is in the area of teacher training where interactive whiteboards are already well established because of their high use in schools (for example all schools in

Wales have been funded to provide at least one interactive whiteboard). Cheaper interactive systems are data projector or whiteboard combinations, which use tablet PCs, wireless graphics tablets or wireless keyboards as remote interface devices.

## Further information

For information about interactive whiteboards see:

The British Educational Communications Technology Agency (BECTa)
http://www.becta.org.uk/teaching/pedagogy/technologies/whiteboards.html

Ferl (an information service run by BECTa)
http://ferl.becta.org.uk/display.cfm?page=250

The National Centre for Technology in Education
http://www.ncte.ie/ICTAdviceSupport/AdviceSheets/InteractiveWhiteboards/

AV Interactive
http://www.avmag.co.uk/resources.list.aspx

For detailed product information, some UK suppliers are:

www.promethean.co.uk
www.tds-whiteboards.com
www.smartboard.co.uk
www.rm.com
www.imagomicro.co.uk
www.interactive-education.co.uk
www.interactive-whiteboards.co.uk
www.copyboards.co.uk
www.mimio.com
www.e-beam.com
www.av-oncampus.com
www.websterboards.com
www.wedgwood-group.com

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