The Case for Interactive Whiteboards for NSW Schools

A White Paper by East Coast Audio Visual (ECAV), August 2008

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A. Executive Summary

There is a revolution underway in classroom teaching, with technology at its core – a revolution possibly more profound in its impact and implications than the adoption, in the eighties and nineties, of personal computers in the classroom. It will be no less controversial. The revolution is further advanced in Europe (Approximately 60% of UK classrooms have an IWB) and North America (In 2006, Mexico contracted for 120,761 IWBs for grades 5 & 6) than Australia. In fact, it is further advanced in many parts of Asia.

In fairly typical fashion, NSW has been one of the slowest states in determining its position on Interactive Whiteboards (IWB) but in doing so it has shrewdly used its buying power to maximize its potential benefits from IWBs.

This paper considers the implications of the NSW DET decision as well as providing background on the case for IWB technologies both in terms of learning outcomes and financial considerations.

In our view, the growing expectancy by parents and governments for greater accountability elevates the importance getting the IWB decision right to a strategic decision for principals and the senior staff of the school.

1. Impact on Learning Outcomes

In 2007 the Centre for Learning Innovation in NSW DET undertook a trail on IWBs (supported by ECAV) across three primary and two high schools, with their executive summary nicely encapsulating the consensus view:

> "The trial established that teachers, with appropriate training and support, were able to use the interactive Whiteboard to improve learning outcomes of many of their students. Children with learning difficulties appeared to have the most benefit. Teachers developed more creative lessons and increased their use of multimedia and internet based learning resources. Students displayed confidence and enjoyment in their learning and many of them improved their assessment results.

Overall, the trial indicated that Interactive Whiteboards have an important role to play in the classrooms of the future.

2. Financial Benefits

Beyond benefits in learning outcomes, however, NSW DET, in its 2008 IWB decision seems to have recognised that there is a financial business case for IWBs *if there is standardisation on the IWB software*. Back in 2004, ECAV identified savings in teachers' time in re-use and sharing of lessons, as well as reduced time of transcribing materials onto a whiteboard amount to a substantial saving over a relatively few years of the order of many hundreds of thousands of dollars per school. For the detailed analysis please refer to sections B & C.

Additionally, there are significant savings in product training & familiarisation as well as IT support.

Lesson sharing and re-use

By standardising on Promethean Activstudio as the only IWB software, the NSW Government has set itself up to be able to reap the efficiency dividend for lesson sharing and re-use not only at the faculty or school level but across the state. In its IWB announcement, the DET indicated:

> "Departmental support for content creation for interactive whiteboards, such as the materials produced by the Centre for Learning Innovation and Curriculum K-12 Directorate, will use the DET standard. Schools currently using alternative software will over time migrate to the Activstudio 3 software for lesson creation and sharing.
>
> There is currently a wide range of teacher developed lesson material saved in SMART Notebook and Microsoft PowerPoint file formats. The Centre for Learning Innovation will provide a range of support to teachers for the use of Activstudio 3 teaching and learning."

Reduced teacher training and support costs

As emphasised in the lead sentence of the CLI assessment on IWBs, formal "training and support" will be required. This has been endorsed by the NSW DET:

> "Professional learning to support the Interactive Classroom Project is being developed by regions and state directorates."

By deciding to only support Activstudio, there is significant reduction in costs in not having to develop and provide training on different products, and the greater likelihood of peer support from other teachers who are already familiar with Activstudio at that school.

This professional learning will extend to the formal external training of teachers – both in the degree courses and post-degree and top-up training. As an example, ECAV has already been approached by the University of Wollongong's Faculty of Education for the purchase and install Activstudio and Activboards.

Similarly, having only one type of technology to support will reduce the support overheads for NSW DET's ICT group.

Leveraging its buying power

Furthermore NSW DET has used its buying power to fashion an approach that disrupts the bundled solutions of the major IWB providers. For the four key components to the IWB solution, it selected:

1.	IWB Software	Promethean Activstudio
2.	The board & stylus	Panasonic UB-T780 hard-surface board and pen
3.	Projector	Sanyo super-short throw or Epson Short-throw
4.	Installation	Dell

IWB Software

By our understanding, NSW DET's assessment for the software included:

- Having the IWB functionality to provide those learning outcomes
- The tools to allow for lesson sharing
- An acceptance to allow the software to operate over multiple types of boards to protect the schools' existing capital investment in IWBs
- Commitment to a multi-year contract.

All other IWB software is intended to be phased out to give a consistent IWB teaching environment throughout NSW. All IWB lessons prepared by CLI, curriculum providers and individual teachers will be in this format. Within a few years therefore, Activstudio will be the preferred product and

many teachers (especially the most progressive) will have large parts of their lessons developed in Activstudio.

Assessment

In our view, this is a very shrewd decision by the NSW DET. Rather than the dozen brands of IWBs producing incompatible lessons that are produced in other geographies, NSW will be able to realise the benefits above. When and how it achieve it will be very interesting - Watch this space!

3. Implications of the NSW DET decision

The NSW DET decision means that within a few years:

1. The NSW DET Centre for Learning Innovation (CLI) will facilitate development and sharing of a large body of Activstudio content tailored to the NSW Curriculum.

2. There will be a large number of public school teachers trained in Activstudio lesson development.

Availability of CLI Activstudio Content

It is not yet clear whether CLI will offer formal access to its Activstudio content to non-government schools. In any event it is hard to see how informal access could be or would be prevented.

Our business case analysis shows that schools that have already invested substantially in non-Activstudio content will realize almost the same benefits as if they had invested in Activstudio, as content sharing within the school as well as sharing with other users of the chosen non-Activstudio IWB will provide the vast majority of savings.

However, where the non-Activstudio investment is limited to only a few boards, a switch to Activstudio offers access to a growing body of NSW curriculum content. This would kick-start IWB adoption by teachers within the school, and so hastens the consequential realization of savings.

Availability of Activstudio-trained Teachers

The notional business case outlined depended on some measurements that we have done of the time to develop lessons. The longer the development time, the longer is the payback period. Access to trained and experienced teachers will hasten the realization of benefits, and hasten the professional development of non-Activstudio-experienced teachers.

Furthermore, as the majority of teachers being recruited by the non-Government sector may come from Government schools, or at least be trained by Education faculties who are already switching their training to Activstudio, non-Activstudio schools may face retraining and experience ramp-up costs.

These considerations suggest that even schools with substantial investment in non-Activstudio schools, might benefit from a switch to Activstudio. The business case will vary from school to school and system to system.

Buying Power

Currently non-government schools can only get Activstudio by purchasing an Activboard. It is seen as unlikely that other Australian educational authorities will be able convince Promethean to similarly unbundle its products.

The End of the Finger versus Pen Debate?

Pen-over (or mouse-over or hover) is the feature that provides pop-ups and the like when you move your mouse or pen over a portion of the screen/board but do not click. Newer technologies are increasingly relying on mouse-over to support enhanced graphical interfaces. Macintosh users will already be familiar with this. Windows users who have migrated to Vista will notice a similar dependency on mouse-over. In a curious twist, the pen-over function is mainly used to provide help text. On the web, Ajax technology is bringing mouse-over based features to many web pages.

As a result, we believe that users will increasingly need support for true pen-over, but the full implications of this are still unclear. As such, we can't comment on the appropriateness of Panaboard chosen by NSW DET, but by our research, the Activboard is the only board which comprehensively supports true pen-over.

The risk of poor AV product choice and poor implementation

The Interactive Whiteboard is a challenge from a human engineering perspective. There are many physical, OH&S and technical issues to consider as part of determining the optimal solution – many of which don't even make it to table for consideration in the IWB debate.

As an example, the NSW Government has recommended that ultra short throw projectors be used as they "provide a more reliable and secure installation, as well mitigating any potential occupational health and safety concerns". This is another advantage of being a "slow mover"; in the UK there have been cases of teachers having peripheral vision problems from extended use of IWBs with poorly positioned projectors.

Handling this OH&S issue doesn't mean everything is now perfect – a poorly positioned projector that is too high will require extreme keystone correction and the risk of poor quality images causing eye strain to students. Conversely if the projector is mounted too low the teacher can bump their head.

We have identified a number of these considerations in section D. Poor decisions or implementation will result in a sub-standard or even unusable IWB environment.

We leave it to the reader to determine how well these have been considered by NSW DET.

4. Document structure

Due to the wide range of understanding and experience in IWBs, we have organised this paper as far as possible into a self-contained sections for the reader to tackle as they wish.

Section B IWB benefits in terms of learning outcomes and potential time savings

Section C Realising the benefits

Section D Physical, OH&S and technical considerations

Section E Background information on the Interactive Electronic Classroom
- A comparison with traditional whiteboard teaching
- Interactive Whiteboard Technology
- Software and Content for IWBs

B. IWB Benefits

1. Learning Outcomes

Does the IWB improve learning outcomes? Whilst, we don't see ourselves as teachers, by our reading there is an emerging consensus that the answer is "Yes".

In 2007 the Centre for Learning Innovation in NSW DET undertook a trail on IWB software[1] (supported by ECAV) across three primary and two high schools, with their executive summary stating:

> "The trial established that teachers, with appropriate training and support, were able to use the interactive Whiteboard to improve learning outcomes of many of their students. Children with learning difficulties appeared to have the most benefit. Teachers developed more creative lessons and increased their use of multimedia and internet based learning resources. Students displayed confidence and enjoyment in their learning and many of them improved their assessment results."

A more tightly scoped research project by Matthew Robinson[2] at the Florida State University tested 4 questions. Whilst it is ambivalent about *direct* learning outcomes, there were strong *indirect* outcomes both for students and teachers:

> "Students exhibited increased levels of motivation and enjoyed the interaction that the board offers. Students were more attentive, contributed more, offered to volunteer more, and all round enjoyed to a greater extent the mathematics classroom that made use of the interactive electronic whiteboard. The teacher's ability to use the board as a focal point and tool of transition led to the student's perceived usefulness of the board, causing greater positive attitudes towards the learning and teaching of mathematics."

The interactive whiteboard reproduces, with enhancements, the traditional chalk and talk teacher's environment. Thus with a *good*, *motivated* teacher, presenting essentially the *same content*, there might be no difference between an interactive whiteboard and teaching *in front of a class* with a standard whiteboard. The italicized sections, however, are important caveats and raise these important questions:

> How does an interactive whiteboard affect teacher (as opposed to student) motivation? … and how does that affect learning outcomes?
>
> What extra content does an interactive whiteboard facilitate, that may improve learning outcomes (e.g. Geometer's Sketchpad)?
>
> What is the effect on learning outcomes of getting the teacher out from behind the PC and in front of the class, when presenting online content other than interactive whiteboard specific content?

We will revisit these questions, and provide some possible answers later.

[1] For the full report, please refer to their website - www.cli.nsw.edu.au/cli/reading/papers/researchpubs.shtm
[2] Robinson's 2004 master's thesis is at etd.lib.fsu.edu/theses/available/etd-06222004-222734/unrestricted/mcrobinsonthesis.pdf .

2. Lesson Preparation

In a traditional classroom environment, lesson preparation is a time consuming activity for a conscientious teacher. Even where content is well established (whether from a textbook, borrowed from another teacher, or in notes from previous years) the teacher may have to spend some time transcribing material onto possibly multiple panes of a whiteboard before the lesson starts. Gaining access to the classroom beforehand may be an issue.

IWB software such as Activstudio or similar, eliminates much of this work. Where the content is already in Activstudio form (perhaps prepared by another teacher, or perhaps the same teacher the previous year) the work is eliminated. Where the content must be generated it is arguably easier to do so in Activstudio or similar. Perhaps the teacher might do it the evening before the lesson at home, on her or his laptop. Where the content is to be based on shared IWB classroom content, much or all of the work is eliminated. We did some experiments with content generation in the Maths area[3]. Based on the times involved the following indicative timings are provided for preparation of a lesson of one hour. Taught content is assumed to be only thirty minutes, the remainder being class working through exercises (from a textbook, not the whiteboard).

	Prepare[4] (minutes)	Setup[5] (minutes)	Total (minutes)
Traditional from notes or textbook	0-15	15	15-30
Activstudio from notes or textbook	30-45	0	30-45
Existing Activstudio content	0-15	0	0-15

While these figures are indicative only, and must be taken with a grain of salt, they will now allow some rubbery thought experiments.

Suppose a single teacher goes it alone with interactive electronic classroom out of her or his own source of funds (at a cost of up to $7,000 this is very unlikely but bear with us). He or she has 24 hours of class contact a week, all different material. In subsequent years, he or she teaches the same material and does not rework lessons. She or he spends the amount of time (hours) shown here in lesson preparation a week, in comparison with what they would have spent without the interactive whiteboard.

	First Year (hours/week)	Subsequent Years (hours/week)
Traditional from notes or textbook	6-12[6]	6
Activstudio from notes or textbook	12-18	0
Existing Activstudio content	0-6	0

We now look at how many years before the initial investment in lesson preparation is repaid.

	New Teacher	Experienced Teacher
Using Easiteach Classroom Content	0	0
Easiteach from Notes or Textbook	3	2

So without sharing the IWB content, it is two or three years before the teacher has made up the initial investment. Coupled with the impracticality of public secondary teachers being tied to a single classroom environment or using mobile whiteboards, it will prove difficult to establish the benefits

[3] Two sample lessons were generated. One based on a lesson in a Year 9 South Australian Maths textbook. The other was based on an exam question in the 2003 NSW School Certificate examination.
[4] Depending on how much customization is needed
[5] For a permanent class room installation – a mobile interactive whiteboard may require anything up to 15 minutes equipment setup time. This is discussed later.
[6] Depending on whether a new teacher or not.

solely in terms of savings in lesson preparation at the *individual* secondary teacher level without significant content sharing. However for *individual* primary school teachers who can secure the funds, "going it alone" may reap immediate benefits in reduced lesson preparation, because of Activstudio's library of existing, shared primary content.

Now let us look at an entire secondary faculty[7] of six teachers (or similar grouping of primary teachers, such as "infants") taking on interactive whiteboards. Only one is a first time teacher. The task of IWB content preparation is shared between the faculty members. Now the average lesson preparation hours per week per teacher are:

	Year 1	Subsequent Years
Traditional from Notes or Textbook	6-7	6
IWB from Notes or Textbook	2-3	0
Existing Activstudio Content	0-1	0

Now IWB developed lessons are providing 4 hours per week saving in the first year, and up to 6 depending on the availability of Activstudio classroom content, plus a further 6 hours per week in subsequent years. This represents a notional saving of the order of $300,000 for the faculty over five years (compared with a five year cost, we shall see, of the order of $68,000). Let's revisit the time in years to pay back the initial investment in content conversion.

	New Teacher	Experienced Teacher
Using Activstudio Classroom Content	0.1	0.1
IWB from Notes or Textbook	0.5	0.3

Thus, counter-intuitively, the availability of existing Activstudio classroom content makes little difference when an entire faculty adopts the technology co-operatively. As this is counter to current perceptions, so it may be an important message to get across to them.

Thus at the faculty level, the benefits in terms of lesson preparation are much more marked, than at the individual teacher level. However, the impact of not having existing Activstudio content is greatly lessened. As we scale up, to school and finally system level, the proportional benefits remain roughly the same as at faculty level.

3. Conclusions about Benefits

While not all agree about the *direct* benefits in terms of learning outcomes, there are significant *indirect* positive impacts on learning outcomes from the Interactive Electronic Classroom.

Education professionals should be canvassed on this issue, but here are our answers to the potential research questions raised earlier:

> *How does an interactive whiteboard affect teacher (as opposed to student) motivation? … and how does that affect learning outcomes?*
>
> Freed from the transcription to the board associated with traditional teaching, we feel that teachers will be better motivated and hence better teachers. We suspect that the ready availability of easily shared classroom content will tend to bring up the standard of poorer teachers; and better teachers to even higher standards as they use time saved in lesson preparation to improve lesson impact.

[7] The term faculty is used rather than department, so as not to confuse with departments of education – another key set of stakeholders in this market.

What extra content does an interactive whiteboard facilitate, that may improve learning outcomes (eg Geometer's Sketchpad)?

We suspect that there is another boost to learning outcomes here.

What is the effect on learning outcomes of getting the teacher out from behind the PC and in front of the class, when presenting online content other than interactive whiteboard specific content?

We suspect the effect is significant. In what proportion of current lessons is such online material delivered by a teacher sitting at a computer?

Beyond the positive impacts on learning outcomes, the major benefit accruing is in the area of lesson preparation time, and this is the only benefit likely to be anything close to quantifiable in the short term. At the faculty level and higher, the benefits in terms of lesson preparation are substantial and more marked, than at the individual teacher level.

The impact of being able to access Activstudio or equivalent lesson content libraries is significant for the go-it-alone teacher, but at the faculty level and higher, the impact of not having comprehensive classroom content is not so significant.

C. Benefits Realisation

1. Costs

There are so many potential products and configurations for an electronic classroom that it is hard to be prescriptive in the area of costs. I have decided to work from an indicative baseline of $7,000 per classroom, with a minimum lifetime of five years, broken down as follows:

IWB
Ultra short throw projector
Boom
Powered speakers
Wallplate and ducting
Wiring, installation, integration of above
Initial teacher training on the products

The major consumable will be projector lamps, of the order of $1,500 over 5 years.

Currently the perception amongst teachers seems to be that interactive whiteboards are expensive, when the costs are presented in this bald manner. A couple of alternative approaches can put the costs in perspective.

Consider our faculty from our discussion of reduced lesson preparation time. Six teachers operate from, maybe eight classrooms. That's $56,000. That's less than the cost of a new computer laboratory (with a similar lifetime, and similar recurrent expenditure) for twenty workstations.

Another way of thinking about the $7,000 per classroom plus $1,500 consumables over five years, is that it represents $340 per student, or about $70 per year per student.

2. Benefits Realisation

We can now see a strong emergent business case, substantially based on lesson preparation savings, with a cost/benefit ratio greater than 1:4 and with additional significant but not yet quantifiable improvements in learning outcomes.

Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	NPV (10%)
-56,000	-375	-375	-375	-375	-$51,989.73
60,000	60,000	60,000	60,000	60,000	$227,447.21

Critics will raise the issue of how these lesson preparation savings can practically be realised. The following are options:

- more effort in quality and impact of lessons
- more material covered in class[8]
- greater time spent on student assessment
- less work hours for teachers

Depending on how the deal is negotiated amongst the various stakeholders, the savings may include all four components or others that we have not thought of.

[8] Realistically some of the saved transcription effort takes place in class time, while the class does nothing or does essentially unsupervised exercises.

D. Physical, OH&S and technical considerations

The Interactive Whiteboard is a challenge from a human engineering perspective. Here are some of the issues a Pro-AV company considers as part of determining the optimal solution.

Adequate image clarity / contrast

Ambient illumination must be adequate for classwork, 300-500 lux, but this conflicts with the need for adequate contrast ratios for legibility of projected text (let alone decreasing saturation of colours). The availability of cheaper bright projectors has eased the problems in achieving this, but classroom specification and configuration still requires careful consideration. For example, with a typical ambient luminance of 200 lux hitting the screen, barely acceptable results are obtained with a 2,000 ANSI Lumens projector. The projected peak luminance at 2,000/1.74 (75" board) = 1,150 lux. So the contrast ratio is 1150/200 or roughly 5.8:1, just above the *minimum* acceptable level of 5:1 as recommended by the AV industry[9] for good legibility. Using an 1800 lumens projector with native 16:10 on a 4:3 screen (as is one of the NSW DET's recommended projector), brings the effective brightness to 1500 lumens and the contrast down to 4.3:1.

Legibility

Similarly, board size, if too small, will reduce legibility of on screen material. On the other hand cost considerations may tend to encourage buying of undersized boards. With Activboard and most other IWBs there are typically two sizes, around 64" and 78". For classrooms, we suspect only the 78" is adequate. For instance, for a viewer at the back of a class room, say 7m directly in front of the board, a standard Activstudio font (20 point Comic Sans MS) is safely above recommended size for legibility for the 78" board, but not for the 64"[10]. Clearly, this topic is amenable to formal analysis, and ECAV is in a position to do this analysis for different classroom environments.

Shadowing and glare

Another issue is the blocking by the teacher of all or part of the projection. This problem is worse with desk-mounted as opposed to ceiling mounted projectors. With a ceiling mounted projector, we have observed that the image blocking tends to encourage good board habits of standing to one side to allow the class to see – a practice needed with traditional whiteboards but not always observed.

Educational authorities in the UK, where teachers have some years of extensive daily use of boards, are concerned that prolonged exposure to glare may damage peripheral vision. This may be true. While we have evolved to deal with the glare of the sun, its impact moves around our retina with the progress of the day and our ordinary outdoor activity. The glare from the projector will be concentrated on roughly the same two areas of the retina for up to six hours a weekday.

The solution is to use boom-mounted short-throw or ultra-short throw projectors whose glare the teacher is typically not exposed to. This also reduces shadowing on the board. NSW DET recommends the use of short-throw projectors on OH&S grounds.

[9] See the Dalite website for recommendations on contrast ratio for legibility. http://www.dalite.com/education/angles_of_view.php?action=details&issueid=31

[10] See http://www.fhwa.dot.gov/tfhrc/safety/pubs/atis/ch03/ch03_02.html for recommendations on symbol size for legibility.

Screen height

Getting the right height for the board requires consideration. If high enough for adults it may be too high for children. If low enough for children, the projector boom and projector may get in the way of teachers. Solutions include steps for children, the use of pointers or "wands" and the dreaded key-stoning.

Key-stoning

The cumulative effects of lower screen height, projector booms, & the taller height of average Australian has resulted in the short throw projectors being mounted at an awkward angle such that the projector cannot be aligned to the screen. This results in the image being key-stone shaped. This is corrected by "key-stoning" which *removes* some pixels from the wider parts of the image until the image is rectangular. Unfortunately, image resolution is compromised in the trade-off, with certain projectors better at managing this key-stoning than others.

Mobility

Interactive whiteboards do not readily suit mobile setups. If the projector is desk-mounted the problems with blocking and shadows become more serious. Furthermore, board must be recalibrated, with each move (or bump).

Robustness

For a classroom environment, as opposed, say, to a boardroom environment, a major buyer concern would have to be robustness. The relative fragility of plasmas and LCD displays[11] rules them out of the classroom even if price and size did not. How well the various Interactive Whiteboard technologies will stand up to a vigorous classroom environment is still an open question[12]. Additionally, the rate of wear and tear is also relatively unknown. As a result of these concerns, all manufacturers are offering at least three year warranties, and often five year warranties, albeit back-to-base.

A further robustness concern is the vulnerability of the system overall to loss of detachable critical components. These include special pens, special electronic dusters, handheld remotes, tablet PCs and even the projectors. Solutions which effectively address these concerns have a significant advantage in the education market.

Audio

Virtually all IWB packages include speakers. Two considerations are often overlooked:

- Maximum volume – accidental or purposeful turning up the volume to high
- Hum and hiss from poorly manufactured or installed speakers.

[11] A well thrown tennis ball will destroy both beyond repair.
[12] There are suggestions that the electromagnetic technology is the most robust.

E. The Interactive Electronic Classroom

1. The Traditional Whiteboard in the Classroom

As simple as it seems, the traditional whiteboard provides one of the most important teaching tools in the classroom. It is *before* the class, and the teacher typically *stands* to one side *facing* the class. The teacher can *alter or add to* material *already* on the board before the class enters, or the teacher may simply *point* to features on the board while *discussing* material. The teacher can *walk* backwards and forwards while doing these things, and can *change* sides. The teacher may illustrate with *body movements*. The teacher may invite students, generally one at a time, to *come forward* and *participate* in board activities. There may be *more than one pane* of a whiteboard, which can be *hidden* and then slid into view when required. The combination of all the features in italics, provides the teacher with a powerful armory of weapons to attack a key classroom problem – controlling and directing students' attention. Therefore, while it may seem painfully detailed, it will be important to understand why the traditional whiteboard environment works. So we will now take a couple of pages to discuss these features point by point.

(1) …before the class…

Because the whiteboard is up there, students are compelled to look up and forward (compared with looking at a textbook, say.)

(2) …teacher stands…

Because the teacher is standing, he or she is more visible, in particular her or his face is more visible (compared with her or him sitting at a keyboard, say.)

(3) …teacher faces…

Because the teacher faces the class, and because of (1) and (2) he or she makes eye contact with students, and can assess facial expressions (for instance perplexed, vacant, enlightened). Students can, in turn, see the teacher's expressions, and can see mouth and lips when she or he is speaking. Compare this with a teacher facing a computer display.

(4) …alter or add…

It seems obvious, but you can't do this working from a textbook, for example.

(5) …material already on the board…

Substantial benefits accrue if the board is prepared beforehand because teachers do not want to spend too much time in class transcribing material onto the board - with their backs to the class.

(6) …teacher points…

Pointing is an important and natural way to control and direct attention. As the teacher's arm is extended and he or she turns their head to look at the object of interest, focus is drawn naturally away from the teacher's face to the object, and then, when the teacher's pointing arm is withdrawn, and the teacher's head turned back to the class, focus is just as naturally drawn back to the teacher's face. It's hard to do this as smoothly and effectively any other way.

(6) …teacher discusses…

We are conversational animals. Our attention is naturally drawn to talking heads, but only when we can see face and lips. Otherwise speech can tend to become a background drone.

(7) …teacher walks…

A moving, animated speaker is more interesting and keeps our attention.

(8) …change sides…

Once more, some variety will maintain interest and attention longer. The handedness of the teacher will be an issue here

(9) …illustrate with body movements…

Gestures and body movements can help greatly with getting a message across – ask any Italian! Expansive body movements tend to hold the attention of boys in particular.

(10) …students come forward…

One of the most powerful tools for holding students' attention is provided by the teacher asking questions of individual students. Students being aware that they might be chosen have a powerful incentive to follow proceedings. Where they have to come out in front of the class, their visibility to the rest of the class is that much greater, as is the corresponding incentive to "get it right". Furthermore, class focus is maintained on the front of the room, where the teacher and board are, rather than the class turning to face a student in his or her seat.

(11) …students participate…

Attention span is greatly extended when students' can participate actively in the lesson. Where that activity includes getting up and walking, the effects on attention are typically more marked.

(12) …multi-pane…

A single lesson will probably require more content than can fit on one pane. Without a multi-pane capability the teacher is reduced to transcribing material during lesson time, with back to the class.

(13) …hidden pane…

On the other hand, if panes which are to be used later in the lesson are visible early in the lesson, they may distract from the material the teacher wishes to focus on.

Thus the overt simplicity of the traditional whiteboard environment hides a subtle and complex set of features which allow the teacher to control and direct class attention, and to gain non-verbal feedback from the class. The interactive electronic classroom needs to reproduce, in one way or the other, most of these features. As we shall see, some current applications of technology in the classroom do not.

2. Interactive Whiteboard Technology

The electronic whiteboard appeared in the eighties. Incorporating a scanner and printer into a multi-pane whiteboard allowed chalk-and-talkers to get a hardcopy of the results of their performance.

The overhead transparency was a contemporary presentation paradigm competing with chalk-and-talk. By the late eighties, transparencies could be printed from computer-generated material, and the first direct projection panels for computers were appearing.

Smart Technologies were the first to combine these technologies, with the addition of a touch sensitive board in 1991. The result was a presentation paradigm difficult for the market to appreciate, hence initially slow to pick up, and whose potential is still being realized and understood. In the educational context, I have chosen to call this new paradigm the interactive electronic classroom.

The basic elements are:

- A pointer-sensitive display surface (which can optionally be drawn on with dry erase markers) which can be:
    - Large display such as LCD or plasma,
    - Forward or rear-projection screen plus projector
    - Conventional whiteboard plus projector (for some pointer technologies such as Mimio)
- A suitable pointer technology which can be:
    - Built-in or overlaid touch-sensitive resistive or capacitive technology
    - Special pens such as electromagnetic, optical triangulation (Mimio) or infrared/ultrasonic
    - Wireless tablet PC
    - Handheld remote control
    - Mouse on PC at the side, or on a lectern
- Suitable display software such as:
    - Notebook (proprietary to SmartBoard)
    - Activstudio (proprietary to Promethean ACTIVboard)
    - Webster (proprietary to Polyvision)
    - MS Powerpoint (generic – runs in any interactive whiteboard environment)
    - Easiteach (generic – runs in any interactive whiteboard environment).

Hence an interactive electronic classroom can be constructed in many ways, with corresponding features, advantages and disadvantages and prices. However the paradigm is perhaps most clearly articulated in the interactive whiteboard, a touch or stylus sensitive board designed to work with a PC and data projector. Different interactive whiteboard manufacturers use different technologies, the most common being Resistive and Capacitive which do not require special styli, and Electromagnetic and Infrared/ultrasonic (eg Mimio) which do.

3. Is the Interactive Electronic Classroom more than just an Interactive Whiteboard?

Lessons consist of more than just the teacher presenting material. There are two classroom roles of the teacher:

- sage on the stage
- guide on the side[13].

Conventional interactive whiteboards support the sage on the stage well, but do not easily support teachers roaming the classroom checking students' work, and referring to the board as needed. Nor is it always appropriate for students to interact by coming out to the front and working on the board. Sometimes it will be useful for them to be able to stay at their desks and interact with the board.

[13] These phrases come from the tertiary teaching environment, where the contemporary thrust is to get lectures to do less of the former, and more of the latter.

The manufacturer, Polyvision, has recognized this need with their Walk-and-Talk[14] series of interactive whiteboards, which have a handheld remote pointing device. An ordinary interactive whiteboard environment can be upgraded to such a system with the addition of a relatively inexpensive third-party handheld remote pointer such as Gyration's GyroRemote[15] or the Logitech equivalent. Alternatively, many projectors include pointing (mouse) support in their handheld remotes these days.

Another solution, mentioned earlier, is to use a wireless connected tablet PC. Both the handheld remote and the tablet PC offer a half way solution without the investment in an interactive whiteboard.

Thus an Interactive Electronic Classroom may include:

1. an Interactive Whiteboard
2. or Remote Handheld Pointing device
3. or both

depending on:

- preferred individual teaching style
- teaching policy (Sage on the stage vs. Guide on the side)
- existing investment
- budget.

4. Software and Content for IWBs

It is useful to contrast the IWB software for lesson development with MS Powerpoint. At first sight, IWB software offers similar functionality to MS Powerpoint, but there is a major difference. Powerpoint has two modes – edit and slide show. In a slide show, the editing tools are unavailable. This limits interactivity during a slide show to activating controls – pushing buttons, using slide controls, starting videos and similar invoking of *prepackaged* functions. (Some add-ons allow some extra functions such as annotation of Powerpoint slides.)

In contrast, within the IWB software there is no distinction between edit and show modes. When showing, *all* the manipulative tools used to prepare content are still available, albeit possible temporarily hidden. So presented objects can be grabbed, moved, reshaped, resized, rotated, hidden or trashed. In addition, a handwriting recognition component allows freehand drawn text to be more or less instantly represented in standard fonts.

In summary, while Powerpoint reproduces the look and feel of an old-fashioned *slide show*, with its pre-packaged artwork and limited interactivity, IWB software reproduces the look and feel of a multi-pane *whiteboard*, with its ability to continuously change and interact with each pane, as well as the ability to move freely between panes. In other words, IWB software reproduces, in enhanced electronic form, the environment that the classroom teacher is most used to presenting material in.

1. Activstudio

Activstudio has been developed by Promethean, and has been on the market in the UK since about 2000, accumulating features and content libraries all the while. It is specifically designed for use with Promethean Activboard and other Promethean products.

It encourages lesson sharing through its portal Promethean Planet.

[14] See http://www.polyvision.com/products/walk-and-talk.asp

[15] The GyroRemote uses gyroscopic technology and connects via RF so it can point through obstacles such as students, lab equipment et cetera. See http://www.gyration.com/

2. Easiteach

Easiteach has been developed by RM and its subsidiary Softease, and has been on the market in the UK since about 2000, accumulating features and content libraries all the while. It runs in any interactive electronic classroom environment, but is specifically designed for use with an interactive whiteboard.

Easiteach sells it own classroom content, with extensive coverage of K-7 (maybe K-10 but seems to get weaker in the upper years) in the UK. The way Easiteach structures and markets "toolbars" seems to be unique. These are relocatable and can be hidden like MS Office floating toolbars. They are typically delivered, together with content packs, as separately priced components, loosely based on subject. Some of the available toolbars are Maths, Science, Literacy and Geography.

3. Smart Technologoes

The other serious competitor to Activstudio and Easiteach is Smart Technologies' Notebook (which only run on Smartboards).

Smart with some 50% of the interactive whiteboard market, has encouraged a free collaborative exchange for educational Notebook content called ED Compass, which has a large repository of classroom content.

4. Other Online Content

In addition to classroom content, there is a large amount of material designed for display on computer screen, which while not necessarily ready for classroom teaching, provides valuable lesson components. This includes:

- General Internet resources such as photos and videos
- Educational material designed for self-paced or one-on-one tuition, sometimes Internet based, sometimes CD/DVD based
- Specialised programs for illustrating concepts in specific domains such as Geometer's Sketchpad[16]
- Material designed for presentation in a Computer Laboratory.

All three major IWB software products allow for the incorporation of such material in lessons.

The advantage of incorporating such content into lessons in this way is that, apart from providing a teaching context for the material, it gets the teacher out from behind a PC in the corner, up in front of the class, able to illustrate with more extravagant body movements and gestures, and, most importantly, able to make eye contact and read expressions.

It should be noted that it is the proliferation of this other online content that has generated a large part of the demand in recent years for data projectors in classrooms.

[16] Geometer's sketchpad is so-called "visualization" software for concepts in Geometry, Algebra and Calculus. It utilizes animation and interactivity via controls, and demonstrates very well. I suspect that it is an example of what many people think Easiteach does, or should do, when they first hear about it. Easiteach provides a more humdrum but arguably more critical function, that of providing a basic environment for classroom delivery of *all* lesson content – not specific concepts with high visual impact. RM resells Geometer's Sketchpad both here and in the UK as part of its Maths Alive collection. For more information and a demonstration see http://www.keypress.com/sketchpad/