

PANACEA OR PROP: THE ROLE OF THE INTERACTIVE WHITEBOARD IN IMPROVING TEACHING EFFECTIVENESS.

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This report on research in progress sets out the background to the use of interactive whiteboards in teaching Mathematics in four secondary schools in the Midlands of the UK. It examines the contention that interactive whiteboards may serve as a stimulant to more effective learning through enhanced understanding and enjoyment of sequenced activities by the pupils. It also considers the view that interactive whiteboard technology can only be truly effective where the teacher stimulates interactivity. The evidence points to the need for schools to consider further the way in which the new technology is being used to achieve improved results.

Introduction. There has been a considerable increase in the number of interactive whiteboards (IAWs) installed in schools in the UK. In part this has come about because of government funding; in part, once schools have been introduced to the technology they have then budgeted to buy more. Although early research showed that the attraction of IAWs was their motivational power through enhanced presentation and the novelty of interactivity there is now a more widespread understanding of the value of interactive learning as demonstrated for example, by McCormick and Scrimshaw (2001) in their analysis of pedagogic change in teaching Mathematics, and by Glover and Miller (2002) in charting change within one secondary school. Both papers highlight the need for pedagogic change - from the didactic to the interactive, and from the use of media as a visual support for lessons to the integration of the technology and media into lesson planning. Greiffenhagen (2000) has shown that the use of the technology as an adjunct, rather than as an integrated element in teaching, minimises interaction and the matching of teaching to the learning needs. Joyce et al. (1997) Tuohy (1999), Collins and Cook (2000) and Glover and Law (2002) provide evidence of the need for a match between teaching approaches and the learning style favoured by individuals and groups in schools. Simpson et al. (1998) and Colley (1998) demonstrate the use of interactive technology within specific subjects and stress the need for changed approaches to teaching method by subject, basing pedagogy on the staged learning processes, the availability of stimulating materials for all learning styles, and the possibility of integrating a number of approaches.

This is happening in many schools as staff recognise the potential for enhancing their own skills in materials' preparation and their subsequent use in a variety of teaching situations. These action research attempts are recorded at, for example, ftp://ftp.promethean.co.uk/research_pdfs/ but are echoed in a growing research literature including Hinostroza and Mellar (2001) in their work on computer studies teaching, and the work of Ligorio (2001) who has looked at the way in which learning styles variety can be built into materials. From all this work it is clear that the maximisation of the IAW as a positive influence on teaching is dependent upon four main factors. These are that teachers should have: the technological fluency to use the IAW in association with other technologies (e.g. internet, computers); a range of appropriate materials to hand, both privately and

commercially developed, as a vocabulary of learning opportunities, so that they can match teaching to context and need at any one time; classroom management skills that maximise the attention span of pupils; and an awareness of the complex interaction of teaching and learning styles, especially the use of visual, verbal and kinaesthetic stimulants to learning.

In short it would appear that the effective use of the IAW in enhancing attainment hinges upon the progress made by teachers in harnessing the additional power of the technology to prompt analysis of the learning process in the teacher, and appreciation of the concepts and applications by the pupil.

Whether the initial cost and the continuing demands for maintenance, staff development and materials development, constitute value for money can only be judged by the way in which the relationship between inputs and outcomes is assessed (Levacic, et al., 1999).

Theoretically, if the IAW is used to maximum advantage so that lessons offer variety, challenge and interactivity, pupil achievement will be enhanced – and the IAW can become a panacea for some of the deficiencies of the traditional classroom. Conversely, if there is no recognisable gain the IAW is only being used as a prop to conventional teaching. This report reflects early work to resolve this issue in Mathematics.

The investigation. A group of Mathematics teaching staff drawn from 11 secondary schools are involved in a collaborative effort to develop, and then assess, the use of IAW related materials in Mathematics teaching. This is part of an investigation funded by the Nuffield Foundation. The overall plan is to compare the teaching, relationships and achievements of pupils being taught the same topics with and without IAW technology. This paper is based on work with nine groups in four schools working on the same topic – fractions. All the pupils taking part were in the first secondary year (aged 11-12).

All the teachers concerned have worked with the Mathematics staff of Keele University Department of Education. The working group's task has been to identify, develop, pilot, assess and explore with university and specialist program authors lessons relating to each topic. Whilst the aim has been to develop materials using IAW approaches it was recognised that the same materials could also be used in different ways in rooms without an IAW. The 'screens' forming the basis of the teaching included elements that were capable of use either with Power Point, or as an Excel program or as an OHP or 'normal' whiteboard or with the IAW. However, the materials developed to enhance understanding are strengthened through IAW use, which also included in-built elements of interactivity. An example is the 'fraction wall' where pupils highlighting and moving fractions at one level could subsume equivalent fractions at other levels – and in so doing gained rapid visual representation of fractions that were greater, smaller or equivalent with others. (See appendix.)

After the series of lessons – typically two weeks' – pupils were asked to complete a 53 element questionnaire based on the framework for pupil experience outlined by Glover and Law (2002). The initial question aimed to assess whether teaching of the topic had been – brilliant, good, OK, boring, poor (and even, don't know). Pupils were then asked to state whether the IAW, OHP, normal whiteboard, chalkboard, computer, or calculator had been

used by the teacher in all, some or no lessons. Pupils were also asked to assess the extent to which a number of pedagogic devices – including the use of equipment, the variety of lesson content, group participation and self-directed learning had been used. Finally in an attempt to ascertain pupil self-confidence they were asked to estimate whether they ‘can do’ ten processes, e.g. add two simple fractions together, or find a fraction of a length. Teachers were then asked to provide general grade data to enable pupil self-assessment to be related to reality.

The intention was to ascertain the relationship between the technology used and the perceived enjoyment, understanding and competence of the pupils. This might, it was argued, give some pointers to the gains from IAW use. It is clear that despite the care taken to evolve a series of lessons that would be consistently taught over a period of time with, or without the use of IAW technology there would be class differences according to: school context; developed teaching skills; previous teaching; familiarity with the pupils and materials; and the ethos of learning

In order to gain further understanding at least one lesson in each school was video-taped and subsequently analysed by a mathematician and the independent evaluator to determine the extent to which external factors may have affected the learning process. To secure consistent analysis of this highly subjective material each lesson was categorised according to a structured analysis. This showed, for example, how the same aim of determining the larger of two fractions may have been differently approached by the nine teachers involved with varying emphasis on interactivity. These summary sheets have been drawn on where necessary in this paper.

Findings. Our first aim was to see how far the IAW made a difference to pupil experience of learning. The questions were geared to assessment of the use of the IAW, an OHP, ‘normal’ chalk or white boards, computer or calculator in the course of the lesson. This was then matched with responses to 20 statements that reflected the content and process of lessons on the topic, e.g. classroom management was assessed through responses to the readiness of teacher help, the collaborative nature of the work, the opportunity for self-directed work, and recognition of differentiation.

In most schools teachers using the IAW tended to use the IAW for all lessons if it was available but two of the group only had access for some of their lessons. All groups followed the sequence of activities devised by the planning group – the gain for those working with IAWs was that interactivity could be used, e.g. in prompting rapid responses to series of questions designed to consolidate learning with immediate visual feedback e.g. with ‘Well done!’ on the board. The video evidence suggests that where teachers had not got ready access to IAW technology they were actually compensating by using ideas from the agreed scheme illustrated in different ways with wider use of computers, OHP slides, and group activities. However, where the teacher made use of the IAW in all lessons, 73% also used the computer as support technology. By contrast, 53% of teachers sometimes having access to an IAW used the computer in lessons, while only 27% of those with no access to an IAW used a computer in lessons. This suggests that those making full use of the IAW are more likely to

use a computer in lessons; it may be that they are more technologically fluent but the reason could be due to the greater accessibility of the computer with an IAW.

In terms of learning and understanding the overall pupil reaction suggests that the use of the IAW made no difference to their experience. There were differences in the detail of some responses and two of the groups, taught by the same person but having one group with, and one without, IAW technology, scored very similarly – an indication that the teacher rather than the technology is the most important element. Significantly, where the teacher had used the IAW throughout, five percent more pupils thought that they had learnt a lot in the topic, and four per cent more thought that they understood the topic.

It appears that teachers who do not have access to an IAW are using the greatest variety of teaching approaches. Responses show that pupils are more likely to experience a range of learning processes and that there is more flexibility where the IAW has not become the classroom focus. Video evidence shows that this can be offset where teachers use an alternative normal whiteboard and a free-standing computer for example to respond to pupils for consolidation. In this sample pupils being taught by teachers with an IAW are twice as likely as others to be using worksheets rather than textbook examples in their work. Teachers appear to use similar collaborative and individual research methods whether they have access or not to an IAW.

Classroom management is a reflection of the flexibility used by the teacher in responding to changing situations. Those with access to an IAW are perceived by pupils to be twice as readily available to help during the course of a lesson, whilst those with no access follow more routine arrangements with fewer collaborative activities. Video evidence shows that this help is likely to be given around the IAW with particular use of previous screen recall. Those pupils with some access to IAWs value this highly and this contributes to the higher level of variety they experience.

Whilst there is little difference between groups in their perception of enjoyment in their lessons there is a marked degree of difference between the groups when asked to comment on the extent to which their lessons had been either ‘brilliant’ or ‘good’. It seems that where the IAW is part of the lesson day by day its potential is being explored and it is a driving force in the teaching, and where it can only be used from time to time video evidence shows that there can be problems with teacher technological fluency and pupil reaction to changed situations. Those with no access fall between the two groups in their appreciation of the series of lessons.

The questionnaire also aimed to ascertain the extent to which the pupils felt that they had gained a series of competencies following the lessons. They were asked whether they could perform ten operations. The answers were related to a Likert scale with two ‘tending to certainty’ and two ‘tending to uncertainty’ replies.

In all responses it appears that pupils feel that they are more competent where they have been taught without the benefit of IAW use. This is possibly because teachers have used a more didactic approach in the non-IAW lessons and pupils, having completed drill type exercises,

feel more competent. However, we feel that later testing of understanding, rather than pupils' perceptions of their own understanding, might produce a different result.

Conclusions. This preliminary investigation offers pointers only. It has been undertaken with a limited number of pupils in different schools, and with different teachers. Although there has been an attempt at consistency by offering teaching based on an agreed set of materials and process of conceptual development, the video evidence shows that there was some breadth of interpretation and alternative approaches to ensuring understanding, processing, application and recapitulation of concepts. Further we have, at this stage, only worked on pupil assessment of capability rather than actual attainment. In the next stage of our work we shall endeavour to link IAW use to actual attainment rather than pupil self-assessment of perceived capability.

The indicators are that where lessons are being taught with IAWs in every lesson the novelty effect has diminished and that pupils see the IAW as a focus offering a variety of expositions and activities. The technology and the available materials appear to drive the lesson. There are exceptions where teachers are so adept with the technology that the observed lessons showed a stimulating approach throughout. This compares with the continuing novelty value of lessons sometimes taught with the IAW, and the considerable efforts made by those teachers compensating for the total lack of IAW technology. As a result the teacher rather than the technology is the dominant force. However, pupils are more ready to see such lessons as didactic and routine although there may be a greater variety in the ways in which concepts are set out. The video-taped lessons indicate that teachers using IAWs are developing their fluency in the use of technology, flexibility in using previously used materials, and the evolution of classroom management approaches that maximise interactivity. Already pupils perceive that IAW based lessons are being used in such a way that differentiation of task and approach is being actively pursued. Such lessons are described as consistently brilliant or good.

Analysis of the group data by class indicates that where teachers have been at the pioneering edge of materials development and the use of IAW in teaching, they are more successful in securing both pupil enjoyment and perceived competence. However, where teachers are using IAWs for the first time, or as part of a programme of teaching with only occasional access, they appear to be more tentative and pupils lack confidence. Where no use is being made of IAW technology good lessons are being taught by teachers using a range of activity, and inter-relating with the sub-groups and individuals within the class.

As the work has proceeded and the lessons taught are being evaluated with the teachers concerned, it is clear that the key to stimulating use is a well-paced lesson that maximises the interactivity capability of the IAW. Discussion with staff has resulted in a list of sixteen ways in which the IAW is considered superior to resources in the 'traditional' classroom. These include the use of multiple screens, annotation of the screen as the lesson proceeds, 'drag and drop', 'hide and reveal', colour and shading, and the capability to recall previous stages in the lesson. Video-evidence suggests that as teachers become more aware of the range of ways of working with the IAW they are gaining confidence and lessons have greater impact.

Although the essential characteristics of lessons with total access to IAW, are aggregated and grouped, it is clear that in a comparatively small sample, one group being less effectively taught with an IAW, and one group enthusiastically taught without a IAW can have considerable impact on results. For this reason conclusions must await the completion of further research. At present our evidence is that whilst more pupils feel that their mathematics lessons are stimulating when the IAW is available further allowance has to be made for teacher quality and approach. Such an incursion into professional capability cannot be built into a research strategy and we shall need to be guided in part by pupil assessment of their learning context. Early evidence is that the IAW is a very useful prop for teachers seeking to diversify their approaches to take cognisance of differing learning styles but it may only become a panacea where good teachers are provided with the necessary time, resources and training.

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Appendix 1

Figure 1: Six example interactive whiteboard screens: the top two are from early work, the other four from more recent work.

The figure displays six interactive whiteboard screens arranged in a 3x2 grid. Each screen has a title bar and a 'TN' logo in the top right corner.

- Top Left: 'A fraction wall'** shows a horizontal bar divided into 12 equal segments. The segments are grouped into rows representing fractions: 1 (red), 1/2 (yellow), 1/3 (orange), 1/4 (cyan), 1/5 (green), 1/6 (light blue), 1/7 (yellow), 1/8 (pink), 1/9 (dark green), 1/10 (orange), 1/11 (light blue), and 1/12 (purple).
- Top Right: 'Combining fractions 1'** shows a horizontal bar divided into 12 segments. Some segments are highlighted in different colors (red, yellow, orange, cyan, green, pink, light blue, purple) to represent fractions like 1/2, 1/3, 1/4, 1/5, 1/6, 1/7, 1/8, 1/9, 1/10, 1/11, and 1/12. Some segments are combined to show equivalent fractions like 1/2 = 2/4 = 3/6 = 4/8 = 5/10 = 6/12.
- Middle Left: 'Equivalent fractions and the fraction wall'** shows the same fraction wall as the top left. A vertical line is drawn through the wall, and a blue rectangle is drawn around it. The text says: 'Drag the rectangle around the wall to compare some fractions. Click New to draw a different rectangle.' There are 'New' and 'Reset' buttons.
- Middle Right: 'Combining fractions'** shows a horizontal bar divided into 12 segments. Some segments are highlighted in different colors. The text says: 'Click on a fraction and drag it into the central area.' There are 'New', 'Reset', and 'Clear' buttons.
- Bottom Left: 'Combining fractions'** shows a horizontal bar divided into 12 segments. Some segments are highlighted in different colors. The text says: 'Continue with more fractions or work out the answer. Use the keypad to enter your fraction into the blue cells. Click Make to see your fraction.' There are 'New', 'Reset', 'Clear', 'Add', and 'Subtract' buttons.
- Bottom Right: 'Combining fractions'** shows a horizontal bar divided into 12 segments. Some segments are highlighted in different colors. The text says: 'Use the new fraction to check your answer. Make a different fraction or click New to start again.' There are 'New', 'Reset', and 'Clear' buttons.

The top two screens are designed in the software provided with one IAW and have been assembled by using the software to copy and paste images from other applications. The software then allows overwriting, movement of objects and drawing of specific shapes, such as rectangles and lines that are used in the lessons. The other four screens are programmed in Flash and can be used on any IAW. Interactivity is incorporated into the design of this software.