EXPOSURE – THE INTRODUCTION OF INTERACTIVE WHITEBOARD TECHNOLOGY TO SECONDARY SCHOOL MATHEMATICS TEACHERS IN TRAINING

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This paper reports ongoing research into the use of interactive whiteboards (IAWs) in initial teacher education (ITE) in a Department of Education in an English university. It outlines the issues of presentation, pupil motivation and teaching and learning as perceived by teachers in training (called associates) and considers the reasons for the greater involvement of mathematics associates in the pedagogic use of IAWs. It relates this to the exposure to the technology whilst in the Department and the associated ITE schools, provides examples of use of IAWs by mathematics associates and concludes that there is now need for further investigation of the processes of learning and their enhancement through IAW use.

Background

There is an increasing use of IAWs in schools in England and Wales. Costing £3,500 for each installation, there are perceived advantages in the use of the IAW as shown initially by Bailey and Chambers (1996) in mathematics and science teaching in the United States, by Greiffenhagen (2000) and by Glover and Miller (2001a; 2001b). Schools have been able to fund the installation through special grants or through allocating school finances. The effect of this is that the majority of the 50 secondary schools in the Keele University ITE secondary partnership now have at least one IAW while some schools have at least one IAW per subject faculty.

The use of IAWs in teaching and learning has not been without problems. Teaching staff already using the equipment comment adversely upon lesson preparation time, the technological aptitude necessary, and the need to develop a truly interactive approach. Latane (2002) has demonstrated that interactivity with all technologies needs to be between pupil and pupil as well as between pupil and teacher; McGrath (2001), in the museum service, has indicated the need for immediacy of response and the opportunity to explore ideas, and Iding (2000) working in ITE for scientists has shown the need for the co-ordination of pictorial, textual and audio materials. There has however, been little attempt to develop sequentiality and extended coherence of understanding – interactivity has been seen as an aid to traditional classroom teaching. However, within the field of mathematics teaching McCormick and Scrimshaw (2001) in an investigation of effectiveness of the use of IAWs have demonstrated the need for a rapid movement along a continuum from more attractive presentation of materials, through sustained pupil motivation, to the achievement of sustained and interactive learning approaches by the teachers involved.

This progression appears to be difficult for those already teaching in schools. Glover and Miller have outlined practice in one secondary school (2001c) and in a group of primary schools (2002) and have identified as 'missioners' those teachers who have become aware of the potential of IAW systems for more effective teaching and learning (2001b). These teachers are characterised by an awareness of the technology involved, a determination to develop this for classroom use by the preparation and development of teaching and learning materials, and an enthusiasm to interest other teachers in the potential of interactive approaches. Other teachers are classified as 'luddites' unwilling to embrace new approaches, and 'tentatives' who are not averse to the technology and its use but fear for too rapid an introduction.

The increasing emphasis on information and communications technology awareness for teachers means that most ITE students are now well aware of the use of computers and basic Microsoft Word, Power Point and Excel programmes for the development of teaching aids, presentational material and enhanced assessment. There is evidence that this has been of value in the development of mathematics teaching and Monson and Judd (2001) have extended interactivity through the development of a system for identifying mathematical misconceptions. The use of the IAW to illustrate and explore such misconceptions enhances understanding through the use of illustrative exemplars, visual representation and spatial movement. It is becoming increasingly clear that ITE students will need to be able to apply this basic experience as schools become more fully equipped with IAW and associated technologies.

To this end an attempt has been made by the Department of Education at Keele University to introduce as many as possible of their associates to teaching and learning approaches by using the IAW as a tool in teaching whilst on the University campus. This has the benefit of developing confidence so that associates going into 'IAW schools' are able to use it in their own teaching. Further they are able to gain a developing competence in the preparation and use of interactive teaching materials. The Department has been developing the technology since 2000 and has been faced with the same problems as schools introducing new approaches. There are now three sets of equipment available (only one set in year one), limited appropriate commercial software is available and some lecturers have been hesitant to use technology with which they do not feel entirely confident. During the first year following installation lecturers were encouraged to look at the potential of the IAW as used by the 'missioner', a mathematician, in the Department. In the second year training was offered to all staff and this is now part of the annual induction for all new staff. There is a clear expectation that all associates will be made aware of IAW technology during their subject training at the university but no requirement that it should be integral to either their teaching or the teaching they receive.

With the installation of the first IAW the lecturers in mathematics decided to use the IAW in all their teaching. In this way their associates are made aware of the technology, its potential and limitations, and of the teaching and learning gains from effective visual representation and subsequent interactivity in question and answer sessions. This approach has not been used simply to introduce new technology but has been grounded in an appreciation of the need for balance in the use of linguistic, spatial and logical-mathematical and logical quantitative approaches to meet individual learning preferences in teaching (Gardner, 1999). The ability of the teacher to respond to lack of understanding by individuals or a group of pupils through re-examining concepts drawing upon already assimilated material stored on the attached computer; the ability to strengthen practice by the use of graded and sequential stored examples, and the linking of visual, spatial and experiential approaches in the development of materials all offer positive advantages as explored by, amongst others Smith (1996) and by Caine and Caine (1997).

Research

The present situation in the Department and in the partnership schools is highly fluid as new equipment is installed and as more associates have the opportunity to use IAW facilities when they go into these schools. As part of the end of year evaluation of the one-year postgraduate certificate in education course associates were asked to complete a questionnaire that sought to elicit:

- the availability and extent of IAW use during a range of training activities within the Department and in teaching practices in the partnership schools;
- the use made by associates of IAW facilities in the schools;
- the perceived benefits to classroom practice of using interactive approaches,
- an assessment of those factors that would enhance confidence and competence in developing teaching competence.

The questionnaire relied principally on closed responses to secure detail of availability and use. In four sections of the questionnaire a five point Likert scale was used to relate experience to assessment of the IAW in the following three areas:

- presentation – the availability of multimedia, the technological flexibility of the IAW and the availability of offprinting material from the screen at any stage;
- motivation – the consequent gains in attracting pupil interest, brighter presentation of material, and the use of multimedia approaches, and
- teaching and learning – through tighter lesson structure, meeting individual needs and enhancing understanding.

Responses were received from 169 associates out of a cohort of 220 (77%). Of these only 52 had made use of IAWs at some stage in their ITE practice in schools and responded to the ‘use’ questions. We have classified subsequent responses according to the extent of use during practice. Although the subject university staff (called curriculum tutors) may have shown enthusiasm and capability in using IAW technology during their campus based teaching it was clear that some associates went into schools that had limited or no facilities and worked with mentors (a subject-based teacher in the school responsible for the progress in school of the associate) who had limited or adverse experiences of IAW use.

Table 1. Analysis of responses by associates who used IAW technology during teaching practice

Subject	Responding group size	Users	Curriculum tutor use of IAW in teaching	Mentor support in school noted by user associates
English	21	1	Once only	1
Geography	16	5	Some lectures	1
History	13	4	Some lectures	1
I.C.T.	16	5	Once only	6
Mathematics	25	15	Most lectures	4
Modern Languages	9	4	Once only	1
Science	43	10	Some lectures	5
Social Science	26	8	Some lectures	7
Total	**169**	**52**		**26**

'Lectures', in standard classrooms, are two-hour interactive sessions where discussion and involvement of all is expected.

Table 1 summarises the responses of the 52 associates who made use of IAWs whilst on their first or second teaching practice. It is clear that there is a great variation in associate use of the technology. The existence of a single, but very keen, respondent in English is explained by the support given by an equally enthusiastic mentor in the practice school; the comparatively high proportion of social science associates responding positively reflects their placement in well-equipped schools, most with post-16 units. Curriculum Tutor access to the IAW equipment in the University, based on policy decisions, varied as is given in Table 2.

Table 2. Tutor access to IAW equipment during University sessions

Subject	Availability of IAW
English, Modern Languages and Social Science	Special booking of room with equipment required
Geography and History	40% of lectures
I.C.T. (in a computer room)	100% of lectures with data projector but no IAW
Mathematics and Science	90% of lectures

From these data it appears that the mathematics associates had a higher level of exposure to teaching and learning approaches making use of the IAW technology within the Department but had a slightly lower level of support within the schools.

The aim of this analysis is to assess the gains from this high level of exposure to new technology during the Department based work when the associates went into schools.

Analysis

The questionnaire was devised to ascertain awareness of the three claimed advantages for the IAW – presentation, motivation and enhanced teaching and learning. The Likert rating for each of the three elements was considered for all those who had made some 'regular' use of the technology – 'for most lessons' or 'daily' and for those who had only used the technology 'occasionally'. The questionnaire offered three indicators of each claimed advantage and so the score for each was totalled and a mean score for subject and element compared. The details are given in table 3 (see below).

Although the number of regular users in the sample is small the mathematics associates appear to have a marginally more positive view of presentation gains and a greater rating for teaching and learning than the rest of the regular users. This is supported by the qualitative comments. There were 72 positive comments in response to the ways in which the IAW had affected associates' approach to teaching and learning. Overall 33 referred to aspects of presentation with comments such as 'much brighter and able to show things more clearly'; 15 to aspects of motivation including reference to 'fun whilst learning and effectively attracts interest', and 14 were pedagogic comments, 11 by mathematicians, related to aspects of teaching and learning. These included comments on the software used, the stimulation of learning through the use of different approaches and the 'availability of ready interactivity'.

Table 3. Mean scores (maximum 15) for each group of claimed advantages in IAW use for mathematics and all other associates

Claimed advantage	**Mathematics regular users (n =3)**	**Other regular users (n =13)**	**Mathematics occasional users (n = 12)**	**Other occasional users (n =24)**
Presentation	**11.3**	10	**10.2**	9.7
Motivation	10.5	**12.6**	**12.5**	10.9
Teaching and learning	**11.3**	7.3	**9.8**	9.25

When asked about the use of multimedia 35 associates (8 of them mathematicians) commented upon the use of the Internet. Positive comments about the use of other multimedia were made by 9 scientists and 1 mathematician referring to video, PowerPoint and microscope use. When asked to cite specific advantages of IAW use 34 associates listed examples of the way in which they had made use of illustrative Internet, datalogging and visual impact work. Fourteen of the mathematicians however showed considerable knowledge of the way in which they had developed interactivity including:

- the use of a graph plotter (such as Autograph or Omnigraph) and a the dynamic geometry program Geometer's SketchPad
- using the features of Excel to help teach about correlation and lines of best fit
- pre-planning materials for use
- use for 'starter activities' in the first ten minutes of a lesson, where the computer can provide instant results
- allowing pupils to visualise ideas, often in a dynamic way

From this evidence we suggest that it appears that there is a progression in associate appreciation of the use of IAWs. The greater the involvement in using the technology the more associates move from awareness of the motivational and presentational aspects of use to awareness of the pedagogic use of IAW material and interactivity in planning effective teaching and learning. This offers a guide to the greater refinement of courses offered within the subject areas in the Department.

The data were then examined against other evidence in the questionnaire to ascertain possible contributory factors in explaining the apparently greater understanding of IAW use by the mathematicians. The results are given in table 4. The education tutor is a non-subject specific University tutor responsible for a group of 20 associates placed in 3 or 4 schools.

Table 4. Possible contributory factors in developing IAW use by associates.

Possible contributory factor	Mathematics users – positive ranking (n=15)	All other users – positive ranking (n = 37)
Used more than four times by the:		
curriculum tutor	100%	38%
education tutor	13%	16%
mentor	20%	27%
Number of whiteboards in placement school sufficient for regular use	66%	65%
Pre-booking of IAW necessary	67%	72%

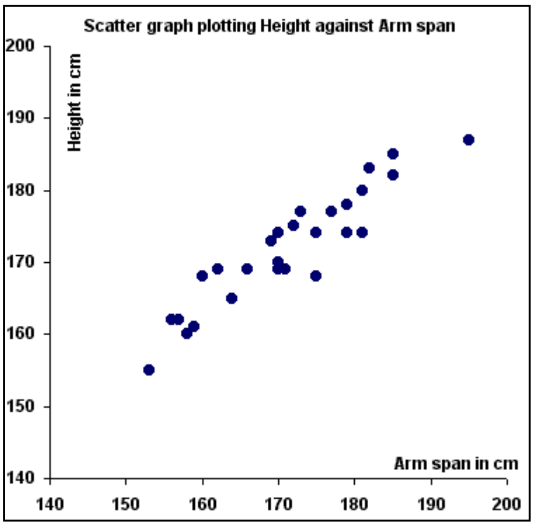
It would appear that the contribution made by the curriculum tutors is of greatest significance in explaining the positive use of IAWs where available to mathematicians in schools. There is little difference between the mathematicians and the rest of the cohort in the contribution perceived to be made by others involved in ITE, or in the sufficiency, and availability of facilities in the schools. Comments from both mathematicians and the others who have been introduced to the technology and have then been unable to use it (40% of the mathematicians; 24% of all other subjects) also point to greater awareness of the potential by mathematicians.

Exposure has clearly whetted their appetite for the use of IAWs. When other subjects are disaggregated according to the number of associates involved and responding, the scientists rank second to the mathematicians, and the social scientists third. This reflects the ranking given by associates to the extent of curriculum tutor use and support in lectures within the Department. There is a similar ranking for the support that could be given in developing IAW use. Eleven mathematics associates seek their own board for all lessons (44% of the group) whilst ten scientists (24% of the group) and five social scientists (18%) see this as the most important factor in developing interactivity in their teaching. The frequent and regular use of mathematically focused software during Departmental subject-based 'lectures' may explain why 40% of the mathematicians look to the further development of commercial materials to enhance confidence in the use of IAWs compared with 18% of the scientists and 21% of the social science group. A further measure of the confidence developed by the mathematicians is that only 40% cite further training as a priority need, whilst 75% of the scientists and 60% of the social science groups do so.

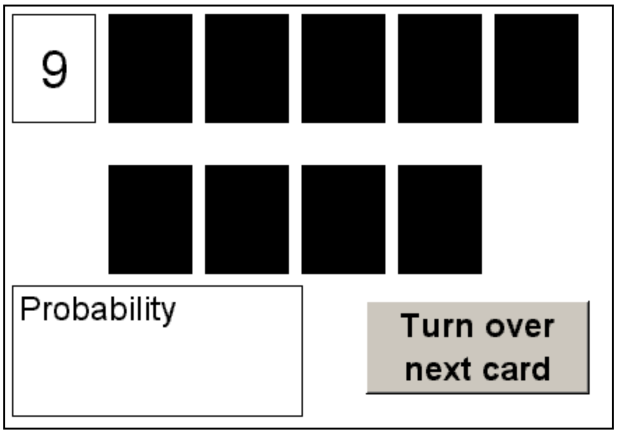
Examples of the effective use of IAWs by mathematics associates

Example 1: 'body measurements' and lines of best fit

In a one hour lesson the associate collected data from pupils on height, arm span and foot length. Pupils' names were already listed in a computer database and pupils entered the three measurements into the computer in the classroom. They then copied the information for later use into a table provided by the associate, so that they could plot scatter graphs of the data and then draw a line of best fit for each graph. Once all the data was entered into the computer the associate quickly produced a scatter graph of height against arm span on the IAW in Excel (shown right). Pupils were then asked to come to the IAW to draw over the Excel chart to show a possible line of best fit. Several pupils came to the board and talked to the rest of the class about the position they chose for the line, until there was final agreement. The associate then used Excel to show the line of best fit and compared it with the pupils' line. Pupils were highly motivated throughout the lesson and keen to participate. The plenary session at the end of the lesson showed that most pupils had a good understanding of lines of best fit and how to place them on a scatter graph.



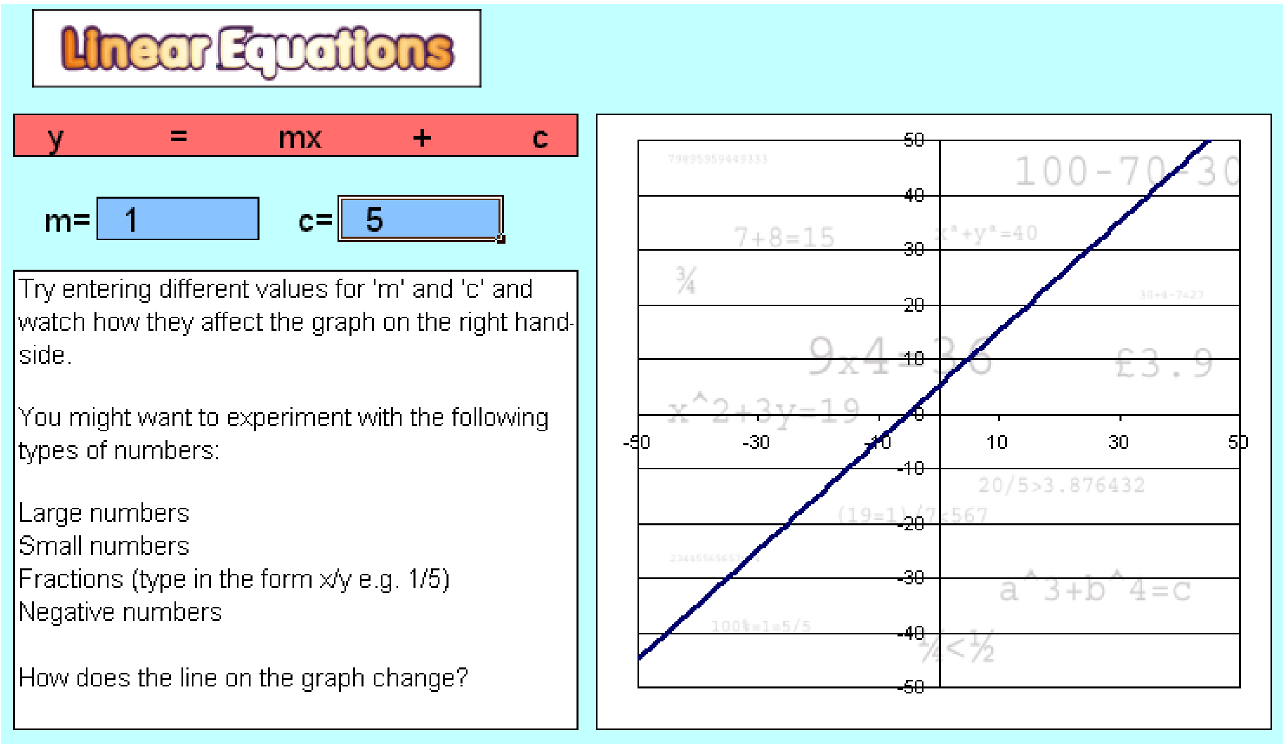
Example 2: 'higher and lower game' and probability



Higher and lower is a popular television game in the UK where contestants win prizes by correctly predicting whether a playing card will be higher or lower than one already showing. The associate had adapted this into an Excel spreadsheet (shown right). His original intention was to use the spreadsheet with pupils to get a broad understanding of probability. However, he adapted his plans after the first successful use of the spreadsheet and used it several times with the pupils. The final time he used it pupils had to discuss probabilities and for each turn of the 'card' they had to work out the probability for a higher or lower card. He arranged the 'cards' so that all numbers from 1 to 10 were used only once. The IAW allowed the associate to use Excel and have pupils write the probabilities on the IAW. Pupils were very interested in the work and by the end of the topic could successfully work out simple probabilities.

Example 3: linear equations on an interactive worksheet

In this case the associate used Excel to make a simple graph plotter (shown below).



Pupils could enter numbers for m and c in the spaces and the graph would be shown on the grid. In the first lesson pupils were in pairs at computers and used the spreadsheet themselves. In the second lesson the pupils were in a normal classroom with the spreadsheet showing on the IAW. The associate read out values for m and c for the equation and asked pupils to predict the position of the line. Pupils made suggestions and then one pupil would draw a line on the grid and explain why he/she had drawn the line in that position. Discussion would follow and sometimes the line would be drawn again. Once the class agreed with the position the numbers were then entered into the spreadsheet so that the pupils' line could be compared with the true position of the line. Pupils were involved throughout the lesson and as the lesson progressed pupils demonstrated a growing understanding of how m and c influence the equation $y = mx + c$.

Conclusion

This limited investigation of one cohort during a period when technology was being developed in both Department and associated schools cannot be conclusive. It is recognised that group sizes are small and offer a snapshot at a stage in development within a given context. There is a subjective and personal interaction between 'missioner' lecturers in the Department or mentors in schools and those associates who are keen to develop their pedagogy through the use of IAW interactivity. This is demonstrated by the one English associate who, working in a school with a 'converted mentor' has developed her teaching with considerable enthusiasm, and by a scientist who, despite the lack of a conventional IAW has developed his own modified system to encourage the interactivity he had seen in other schools.

Consideration of the evidence suggests that the mathematicians having access to the use of IAWs have used them more consistently as an integral part of their teaching than those in other subjects. There are six possible reasons for this.

- The lecturers in the Department made consistent use of the IAW and developed associate awareness of the use of prepared materials.
- As the IAW requires a computer, one of the 'incidental' advantages of the IAW classroom is that a computer is available to the teacher 'without effort'.
- The availability of commercial and Keele developed materials offers associates both sequentiality and confidence in the planning and delivery of lessons.
- The integrative nature of these materials, and of materials developed by associates using models of good practice, appears to enhance classroom control, pupil stimulation and the development of pace in lessons.
- Mathematics concepts, for example geometry, are most easily taught through visual representation, and the use of logical and spatial manipulation.
- The emphasis placed by the curriculum tutors on ensuring that associates used IAWs when they were in an school with IAWs.

These suggest there is need for a developing pedagogic framework so that the issues surrounding the rationale, resourcing and pedagogic enhancement of interactivity can be analysed, conceptualised and applied in future teaching applications.

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