The positive impacts of interactive whiteboards on student learning outcomes in FE colleges, and the conditions under which outcomes can be maximised.

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Abstract

This paper draws from a wider study on the use and impact of ICT within FE colleges. The research questions addressed are: what is it about the ways interactive whiteboards (iWBs) are being used that produce positive impacts on student outcomes, and what institutional and personal factors determine which teachers use iWBs effectively? Multiple case-studies of 6 colleges were designed using a new framework for classifying e-learning uses (ELUs) according to the learning context, learning objectives and the types of software and activities being used. Tutors' beliefs in the efficacy of iWB use, their intentions for use, teaching style and pedagogical skills, and the subject taught all affected the ways in which iWB were deployed, and in particular the degree of multimedia and pedagogic interactivity. Tutors who made a lot of use of iWBs were in colleges where the leadership vision prioritised ICT within teaching and learning. The strongest impact on student outcomes occurred where iWBs were used in a variety of ways, use was appropriate for the subject, and congruent with the teachers' purposes and intentions for students' learning. Tutors who made little use of iWBs tended to be in colleges where the emphasis on management of learning was stronger than on supporting pedagogic development, and/or they were unaware of the potential of iWBs particularly in relation to their subject.

Introduction

E-learning is central to education and training policy, with the government's e-strategy 'Harnessing Technology: Transforming Learning and Children's Services (DfES, 2005) setting out a bold vision for transforming the learning experience. However, evidence of the impact of new technologies on learning is still a contested area with some writers making bold claims about outcomes, while others regard such claims as optimist-rhetoric (Reynolds et al., 2003).

This paper draws from a wider mixed methods case study research project, funded by the DfES, to examine the impact of e-learning in FE colleges (Finlayson et al., 2006). The full study examined: how ICT equipment was being introduced, used and supported within FE colleges, the impact this use was having on student intermediate and end-point outcomes; and the effect of contextual factors and factors at the teaching and learning interface on impact.

FE has not always received the same level of support and guidance for the development of ICT (often referred to as ILT, information and learning technology, in colleges) as schools. For example FE lecturers were not part of the laptop for teachers scheme. However, significant investments in ICT infrastructure in colleges, supported by e-learning content development and national training initiatives, for example through the National Learning Network (NLN) and Further Education Resources for Learning (FERL) have opened up possibilities for transforming learning and teaching in the sector. Annual surveys of ICT implementation within colleges since 1999 demonstrate that significant progress has been made (Becta, 2005), but implementation in the college sector as a whole is still at a relatively early stage with much unevenness both within and between colleges (PriceWaterhouseCoopers LLP, 2004). The initiatives driving forward ICT in the college sector have given particular prominence to use of the internet, availability of computers for students use, and setting up of virtual learning environments (VLEs) driven by notions of efficiency, sharing of teaching materials and avoidance of duplication. While some research projects such as the ICT testbeds project (Becta, 2007) has focused on colleges as well as schools, less attention has generally been given in the research literature to e-learning in colleges than either the school or HE sectors.

This research focuses on interactive whiteboard (iWB) use in FE colleges. The specific research questions to be addressed are:

1. What is it about the ways iWBs are being used that produce positive impacts?
2. What institutional and personal factors determine which teachers use iWB effectively? (i.e. with positive impact on students' intermediate outcomes such as: understanding and engagement with the subject; and the end point outcomes of retention and attainment.)

Evidence of impact of iWB use on Student Outcomes

The implementation of iWBs into schools and colleges is still at an early stage, so inevitably research evidence is limited (Glover et al., 2005), and most empirical work examines the early stages of implementation, for example the recent London Challenge evaluation (Moss et al., 2007). The majority of studies have gathered school teachers' and students' perspectives on, and perceptions of outcomes from, iWB use. Their responses have largely been enthusiastic. Smith et al.'s (2005) review of the literature on interactive whiteboards found that the potential benefits were perceived to be flexibility and versatility, multimedia/ multimodal presentation, efficiency, supporting planning and the development of resources, modelling ICT skills, and interactivity and participation in lessons.

Studies focusing on the stages of development in iWB use claim that there is a progression from getting to grips with the technology at the early stages where perceived gains are in the quality of presentation and motivating pupils, to greater concern with pedagogic issues and potential as use continues (Glover et al,. 2005). Somekh and Haldene (2005) propose a 5 stage hierarchy of skill levels that teachers pass through, the first three stages involving 'pedagogic exchange' where they adapt and extrapolate via

the technology their existing pedagogy, so they do familiar things better and stages 4 and 5 where they introduce pedagogy specific to the iWB.

Despite widespread belief in the potential of iWBs there is very limited and mostly cautious evidence of their impact. For example Smith et al.'s (2005) review concludes that 'there is almost no evidence of measured gains in pupil progress and long–term achievement' (p166). As Twining et al. (2006) point out evidencing impact of any ICT innovation is problematic because: demonstrating causal links between interventions and learning gains is difficult; one size doesn't fit all and so conclusions can only be drawn in relation to specific technologies enhancing learning in specific ways within particular contexts; and there is a mismatch between the measures used to judge learning gains and the learning facilitated by ICT.

Early suggestions that use of iWBs (or any other ICT) could bring about positive changes in pedagogy of itself have been found wanting. In particular the iWB was perceived as a way of shifting teachers' whole class teaching from a didactic to a more interactive approach. The issue at the heart of this claim is the understanding of the meaning of term 'interactivity'. At a simple surface level iWBs have been regarded as an interactive tool because of the flexibility in presentation of multimodal materials, and the ability to use touch to move objects on the screen. However, research suggest that the pedagogic meaning of interactivity at a deep level involves engaging pupils' thinking processes, most generally through discussion with peers and teachers, and using theatrical anticipation and students' own explanations in advance of revelations, not merely taking turns to go out and make some changes on the iWB. Tanner et al. (2005) argue that 'Although the iWB has affordances to support interactive teaching, offering the opportunity for pupils to be allowed to explore their own ideas and share them with the class in a reflective discourse, such affordances are mediated by teachers' (p7), and suggest that teachers may need to make the transition from traditional to more interactive pedagogies in a non-ICT context before they can recognise the affordances offered by iWBs. Similarly, in comparing literacy and numeracy lessons taught using iWBs and without iWBs Smith et al.(2006) concluded that 'While it should be argued that the IWB is a useful presentational tool to have in the classroom, the findings suggest that such teaching by itself will not bring about fundamental change in the traditional patterns of whole class teaching' (p455). They found lessons using iWBs contained more whole group teaching at the expense of group work, and evidence on the quality of interactions showed both strengths and weaknesses associated with iWB uses. The lessons with iWB had more teacher open questions and more answers from pupils, but these answers were briefer that in non-iWB classes. Teachers in iWB classes spent the majority of their time explaining or using highly structured question and answers, with the recitation script (initiation, response, feedback) more evident in iWB than non-iWB classes.

The Study Design

Conceptualising e-learning use

While we approached the research with the belief that iWBs could provide a tool for deep level interactivity, we had few preconceptions about how tutors could or should be using iWBs and other ICT facilities within their subject teaching. Cox et al.'s (2004) review of research literature showed that specific uses of ICT, when closely related to learning objectives and relevant to the intended teaching and learning purposes impact positively on learning, and raise student attainment. However, conceptualising the type of e-learning use is problematic as the same ICT tools may be used in qualitatively different ways and for different purposes, and each use may result in different impacts on the learning experience and student outcomes. In order to address this issue we developed and used a new framework for classifying e-learning uses (ELUs) according to the learning context, learning objectives and the types of software and activities being used. Three main groups of e-learning uses were identified: e-learning as a medium for facilitating and managing learning; e-learning as a presentation tool; and e-learning as a problem-solving/learning tool. Each group was then sub-divided according to the degree of interactivity or student control within each particular use (the *i* factor). Table 1 shows examples of different e-learning uses using this typology.

Table 1: ELU grid: Examples of e-learning uses at different levels of interaction or student control

e-learning use (ELU)	**1 low *i* factor**	**2 mid *i* factor**	**3 high *i* factor**
A **e-learning as a medium**	downloading teaching material from a VLE; printing out text and pictures from the internet (given the site or key words)	contacting tutor with individual query; reading discussion board; making own search of internet for a purpose	participation in active group discussion on-line; creating own web page for a purpose
B **e-learning as presentation**	tutor uninterrupted presentation of information; student preparation of word processed assignment	tutor presentation with student questioning; student preparation of presentation for peers	tutor presentation with student control, anticipation and explanation; student group presentation for staff and peers
C **e-learning as a problem solving / learning tool**	completing exercise using a pre-prepared spreadsheet; learning how to use other tool software(CAD/CAM etc)	extending a given spreadsheet to solve new problems playing creatively with software	creating own spreadsheet to solve problems using software purposefully within a particular task / social context

iWBs most obviously come into ELU use B, e-learning as presentation; here use of additional peripherals such as voting software, or tablet PCs may be deployed to give individual students greater control and interactivity. iWBs may also be used as a problem solving/ learning tool (ELU C), as for instance in the use of an iWB within a mathematics problem solving session, or in science using simulations or on-line data collection

software. Whilst the ELU framework provides a helpful analytical tool for exploring relationships between ELU use and outcomes, the three different ELU uses can overlap and co-exist in a single learning environment, and different degrees of interactivity within an ELU use may occur at different points within a single session.

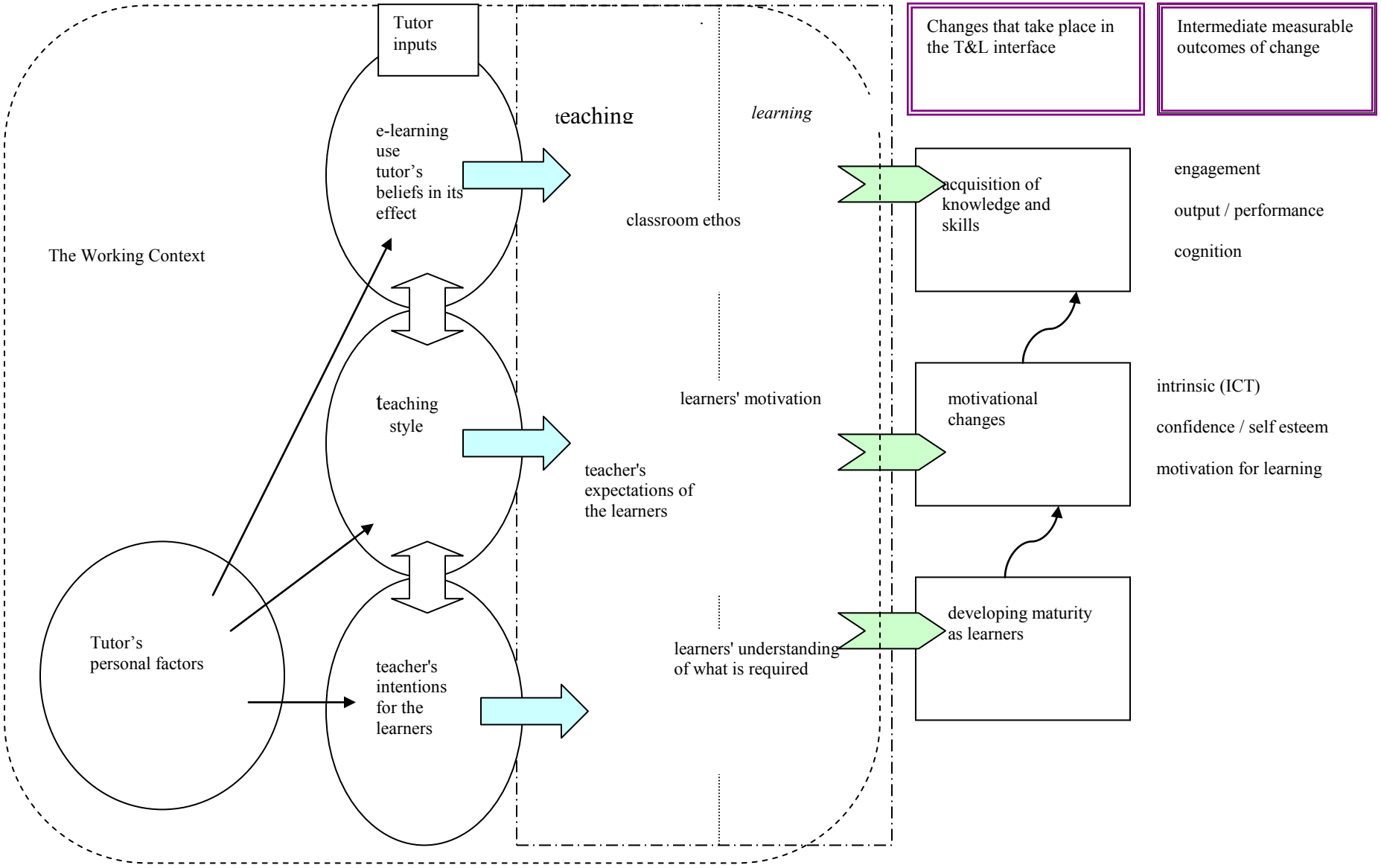
Conceptual model

This paper compliments some of the research carried out in schools, in looking particularly at the use of iWBs in FE colleges. Research in schools has shown that the amount and type of iWB use varies according to the teacher and subject, and the kind of changes iWB use brings about are largely dependent on what teachers think it is for (Moss et al. (2007). Most evidence to date in support of iWB use comes from maths, science and to a lesser extent English (Glover et al., 2005), yet the different curriculum requirements of subjects affect the way teachers interpret and use iWBs (Moss et al., 2007). Teachers' beliefs in the efficacy of ICT, understanding of its potential, and confidence and competence in using ICT are key factors in determining use (Glover et al. 2005; Smith et al. 2005), as are the teacher's pedagogical intentions and approaches discussed earlier. Regular access to equipment is essential if teachers are not to become frustrated with implementing new iWB approaches. Availability of equipment, teacher attitudes towards ICT, and their competence in relation to ICT use and their general pedagogic competence are all in turn influenced by contextual factors operating at all levels within the college. These contextual factors also influence students' expectations about learning and teaching and attitudes towards ICT use.

Building on this understanding of the influences on ICT use and outcomes we used an explicit model of learning activity taking place within a social context under a succession of other contextual constraints. The overarching conceptual model sees the teaching and learning interface as the kernel within a number of concentric shells relating to the subject area, the department, the site, the college, and the local and national educational context.

Our conceptual model of inputs and outputs at the teaching and learning interface (Figure 1) derived from the literature was refined through an iterative process of developing and testing out mini-hypotheses from the data as it was collected. The principal teacher inputs at the learning and teaching interface investigated were the teacher's beliefs in the effect of ICT use, the teacher's intentions for the particular learning group, and the teaching style. These contribute to the general classroom ethos and the tutor's expectations of learners. Underpinning the principal teacher inputs are factors such as teachers' confidence and competence in using ICT. Learners bring to the interface their own motivations, and their own interpretation of what is expected of them. Outcomes were envisaged at three levels: firstly the acquisition of knowledge and skills which is directly related to students' attainment and output performance; secondly motivational changes which create favourable conditions for the acquisition of knowledge and skills and may relate directly to student retention; and at the deepest level the developing maturity of the students as learners. The teacher inputs together with the contextual

Figure 1: Conceptual Model of the Teaching and Learning Interface



affordances and restraints determine the ELU chosen, for example the tutors' choice of ELU may be constrained by their beliefs in the efficacy of ICT for transforming the learning experience. The different teacher inputs may be interrelated and are not easily separated out and attributed to particular outcomes. This is because the ELUs cannot operate without the teacher as orchestrator of how they are used. However, a particular ELU *with* a particular teaching style may relate to outcomes not achieved otherwise.

The principal contextual factors investigated were leadership maturity; technical maturity and workforce maturity, college organisation and structure, and communication and linkages between faculties, levels and functions. Notions of leadership maturity, technical maturity and workforce maturity were drawn from Underwood and Dillon's, (2004) conceptualisation of Maturity of e-Learning Development which provides a measure of how far schools or colleges have progressed along the journey to full integration of ICT. Contextual factors impact on decisions and the ICT culture at whole college, departmental, and subject group levels, most directly impinging on the teaching and learning interface by determining teacher and students access to ICT, and teachers readiness to use ICT.

Data Collection

The research comprised case studies of four subject areas: maths, science, health and social care, and vocational provision including entry to employment (E2E) in six general FE colleges in different English regions. In order to make meaningful comparisons between colleges specific courses were selected, which represented a range of levels and types of student cohorts; these were GCSE maths, A level science, level 2 vocational courses and level 3 health and social care. Data at the teaching and learning interface was collected through interviews with tutors on two occasions, a "reasons for using ICT" questionnaire completed by tutors, observations, tutor e-learning use and impact diary record sheets, student focus groups, student questionnaires and course attainment and retention data. The students completing the questionnaire and taking part in focus groups were those taught by tutors who were the subject of the study, so that student data could be matched directly with tutor data. Contextual data was collected from relevant course leaders, ICT personnel, middle and senior managers, and from college documents. In total 47 tutors, over 500 students and 28 senior managers, middle managers and ICT personnel participated in the research. The distribution of tutors by college and subject area is shown below.

Table 2: Number of tutors in each college and subject area

College	maths	science	HSC	E2E/voc	total
A	2	2	1	3	8
B	3	3	2	1*	9
C	2	2	2	2	8
D	2	2	2	2	8
E	3	2	2	2	9
F	1	1	1	2	5
Totals	13	12	10	12	47

*(vocation course in media studies)

As part of the data collection we were able to observe teaching sessions using iWB by tutors whom we had already interviewed on their purposes in using the ICT and beliefs in its efficacy, within a department and college for which we had knowledge of the facilities, technical support available, and the priorities and vision of the senior leadership. We were also able to interview and observe other tutors who chose not to use iWBs, even though they were available.

Patterns of use of iWBs

At the broadest level the study found that tutors fell into three different categories: those who had only just gained access to iWBs or had insufficient access to teach regularly using them; those who were making a lot of use of them; and those who had good access but saw little purpose in using them. The detailed picture is more complex showing variation in use between subjects, between colleges and even between individual teachers teaching the same course in the same college. This section sets out where and when iWBs were used and for what purposes; later sections discuss how factors at the teaching and learning interface and wider contextual factors influenced this use.

How many tutors had an iWB OR a computer and data projector available to them and how many of these tutors used them?

Table 3: Number of tutors with iWB or data projectors available and use

College	No. of tutors	With iWB	iWB poss	With DP	With No access	Use regularly
A	8	6	2	0	0	7
B	9	1	8	0	0	2
C	8	4	0	3	1	5
D	8	3	0	3	2	4
E	9	9	0	0	0	5
F	5	1	0	2	2	3
Total	47	24	10	8	5	26

With iWB= have iWB available to them in their teaching rooms for most of their sessions.
iWB possible=have iWB available to them for some of their sessions, or in mobile form requiring setting up
With DP= data projector and computer are available for use in most of their sessions.
With No access: to dp or iWB= other than for occasional sessions (e.g. once per term if booked in advance)

On a regular basis half of the 47 tutors had access to an iWB (24), and a further 10 could arrange to have access. Eight other tutors had only data projectors available to them, and 5 had no regular access to any electronic visual teaching aids. All the tutors bar 4 who had direct access to iWB were regularly using them, of these two tutors often had classes where the students worked on their own computers, and the iWB was then used only occasionally for demonstrations. Of the 10 tutors who only had access to mobile equipment that needed setting up, 2 were using iWBs for some classes when this was possible, the other 8 were not choosing to use the less easily accessible equipment. Three

science tutors in 2 different colleges were using data projectors, as this was all they had access to. Two vocational tutors (teaching in the area of sports studies) also used data projectors during particular parts of their courses.

There were tutors with iWBs available to them who were not using them very much, or at all. These mostly fell into three categories:

- courses where students generally worked hands-on, so the iWB was only used for demonstration and occasional student presentations;
- newly installed equipment in which technical issues had not been fully addressed;
- tutors who were unconvinced of the value of ICT in education and/or saw the use of additional technical facilities as incompatible with the requirements for their particular student groups.

How were the iWB and data projectors being used in different subject areas?

Table 4: Use of iWBs and Data projectors by subject

Subject area	maths	science	HSC	E2E/voc	total
No. of tutors	13	12	10	12*	47
With iWB	4	6	6	9	25
IWB possible	4	3	2	1	10
With dp	1	3	0	2	6
With regular student hands-on access to computers	0	0	4	10	14
With no dp access	4	0	2	0	6
Used iWB or (dp) regularly	3	6 + (3dp)	5	7 + (2 dp)	21 + (5dp)
% of subject tutors using iWB or dp	23	75	50	75	55

Across this sample of 47 tutors from six colleges 55% were using iWB or data projection facilities in their teaching. The distribution of resources varied across the subject areas, with the vocational courses being best provided for. These student groups also had the most access to hands-on computers during class time, which sometimes led to the iWB being used only for initial demonstration purposes, before the students began their own work. The highest use was by vocational and science tutors (both 75%). The lowest provision of equipment, and also the lowest take up of it was in the area of GCSE mathematics teaching.

How were tutors using particular applications?

Table 5: Number of tutors in each subject area using particular applications

Subject Area	maths	science	HSC	E2E/voc	Total
Written PowerPoint slides	2	6	5	9	22
2D pictures and diagrams	3	9	5	8	25
Animation (video clips/ simulations)	1	6	4	8	19
IWB highlighting moving etc. software	3	2	1	6	12
Extension* or voting application	0	2	0	2	4

*Extensions to iWB use include linking to live experiments, on line data collection and projection and annotation of live microscopic images etc.

Different subject areas clearly have different teaching requirements. Looking at the ways in which the iWB was used, it is clear that the visual impact of pictures, diagrams and video clips were a key feature in their use. Written PowerPoint slides were also commonly used, particularly in the introduction and summing up of teaching sessions. Video clips were frequently used in vocational areas to demonstrate particular skills or procedures, such as food preparation, carpentry procedures or body movements in sports. All these uses could be carried out equally well with just data projection facilities and generally did not require the interactive facilities of the iWB. The programmed interactivity of the iWB, in enabling handwriting and annotation to projected slides, highlighting, rearranging, saving and recalling, was used by less than half of the tutors with iWBs. However in mathematics and science teaching (science units also occurred within HSC and vocational sport courses) it was often helpful to highlight and annotate a diagram, to bring out the important points. For this the integral interactive software in the iWB was very useful. All the mathematics tutors who used an iWB took this approach and engaged and held the students' attention in this way. Only 2 of the 6 science tutors with an iWB fully exploited these facilities. A further 3 science tutors had only data projectors to use, though one of these tutors ingeniously projected the computer image onto a white paper screen and annotated the diagram onto the paper. This had the same immediate impact as using an iWB, but could not be saved and was rather more difficult to go back to for clarification. The same tutor also generally showed the images twice, the first time whilst explaining sequentially how the different parts fitted together, and the second time, later in the same session, to remind the students of the holistic view.

Positive impacts

The conceptual model described earlier suggests that the intermediate outcomes from the use of e-learning within the teaching and learning interface could be clustered into three

overlapping effects: effects directly relating to acquisition of knowledge and skill, motivational effects, and developing maturity as autonomous learners.

Acquisition of knowledge and skills was considered in terms of: engagement factors such as attention, concentration and remembering, which make the student more receptive to learning; cognitive factors, which making the learning materials more accessible and aid understanding; and performance factors, producing better outputs and developing skills. iWB use had a positive impact on engagement and cognitive factors.

The use of iWBs as a presentation tool (ELU: B1, B2 and B3) had a strong impact on the engagement factors. Students focused on the learning through watching the tutor and seeing what other students were doing, and interacting with it. This was shown to be very effective with highly visual materials, such as diagrams, pictures, animations and graphs. However it was also effective with a visually unpredictable tutor style which used the iWB software to highlight and move objects around with a purpose. Students had to be alert to follow what was happening in such teaching, in contrast to the presentation of written PowerPoint slides, which tended to lead to students losing concentration. This style of e-learning use both attracted students' attention, and held their concentration, particularly when the students expected to be asked to take part. This could be through direct verbal questions or being asked to write on the board, or using voting software where all students had to show what they understood. This did not appear to be a novelty issue; we found that students maintained their enthusiasm over an entire year of study. However, good student-focussed pedagogy and an understanding of how the iWB software can be used within the subject area were essential to its success.

Cognition was facilitated through interactive presentations (ELU: B2), students' own individual or group presentations (ELU: B3), and using problem solving/learning tools (ELU: C2, C3), and using revision sites. Although the iWB was sometimes the technology selected for using problem solving/learning tools, students also worked on these on individual computers in class situations and via the VLE or web as directed study. Understanding was helped by different ELUs in different ways. In the classroom situation interactive presentations (ELU: B2) with PowerPoint or iWB software, such as simulations or role play which involved anticipation, and discussion of 'what if?' scenarios, and reasoning about likely outcomes were very helpful in developing understanding. Interactive presentation allowed objects to be hidden and revealed, simulations allowed different variables to be changed and the effects noted, and there was a built in ability to go back and forth over teaching material. Crucial to this approach was the anticipation and discussion as an interactive whole class activity. It also required good student-focussed pedagogy. Peer group presentations (ELU: B3), where the preparation had been guided by the tutor, but developed by a small group of students similarly developed deeper understanding.

In looking at the actual impact of ICT on students it became clear that the motivational changes were actually part of the wider picture of developing maturity as learners. Most ELUs can be used with the intention of raising motivation. From the tutor interviews it was clear that some tutors mainly used ICT in order to introduce more variety into their

sessions, to motivate the students to attend and get involved. A few students did find ICT use more fun, and more interesting, but it is such a common part of their educational experience now that it was taken for granted by the majority of students. However, most did enjoy specific iWB use such as preparing presentations (ELU: B2; B3) and developed self-esteem, providing the activity had a clear purpose and tight timing, and also when it involved working in groups. Very few enjoyed using ICT for its own sake.

A few tutors deliberately set out to develop autonomous learners, negotiating their learning programmes with them, supporting them with basic information handling skills, and setting challenges for them to meet, both individually and in groups. Much of this initial teaching was done in face to face sessions, but e-learning (using a wide variety of ELUs) underpinned most of their learning activities as well as course organisation and management, and as the course progressed there was growing reliance on student directed use of ICT. As part of this overall use of e-learning students regularly used the iWB interactively during class sessions with subject-specific software (ELU: B2, B3 and C2). Their tutors used the iWB in a variety of interactive ways, including the use of voting software and interactive quizzes for formative assessment purposes. These particular courses were successful in changing the attitudes of the students, empowering them as learners, and led to cognitive gains. Students developed persistence, self-esteem, the ability to make their own decisions on how to work, and also learned how to collaborate. They were also beginning to recognise how they could learn best, and chose realistic planning to get work done. The tutors put in a great deal of time for background preparations and support. They all had good general student focused pedagogy, and built the amount of student control they encouraged over the course.

The case studies revealed very few examples of e-learning use leading directly to improved retention or achievement rates. The courses described in the previous paragraph which had strong intermediate student outcomes also had attainment levels above those which would have been predicted from the students' entry scores, possibly indicating that improved intermediate outcomes lead to improved end-point outcomes. However, it was difficult to separate the impact of e-learning use from other confounding factors that impact on success rates. The tutors in these cases had exceptionally good understanding of how learners learn and how they could improve their students' ability to learn.

Factors influencing the use and impact of iWBs at the teaching and learning interface.

The main factors influencing the use and impact of iWBs at the teaching and learning interface were the subject, a range of factors relating to the tutor, technical issues and the concurrent use of other ICT. These factors were often inter-related.

Table 6: Regular users – by college and subject area

College	maths	science	HSC	E2E/voc	total	% of tutors
A	2	1	1	3	7	88
B	0	1	0	1	2	22
C	0	1 (1)	1	2	4 (1)	63
D	0	(2)	2	0	2 (2)	50
E	1	2	1	1	5	56
F	0	1	0	(2)	1 (2)	60
ALL	3	6 (3)	5	7 (2)	21 (5)	55
% of tutors	23%	75%	50%	75%	55%	

Fewer than 25% of maths tutors regularly used iWBs or projection facilities. This may partly be explained as tutors in maths were less likely to have had iWBs installed in their teaching rooms than vocational tutors. However, it was also maths tutors who were most adamant that ICT had no place in their sessions. A few maths tutors saw the iWBs as useful for visual elements, breaking down mathematical processes, and going back and forth, but many thought it was a distraction to their teaching. They often claimed that the heavy content of GCSE maths (in most cases being taken as a re-sit) did not leave sufficient time for ICT use.

Science tutors apparently did use iWB or data projectors, but much of this use was for a short Powerpoint introduction to a class, and for summing up at the end. Many science tutors were unaware of specialist subject software and applications, though others valued the use of visual projection for focal discussion of results and other data. Several science tutors talked about demonstrating simulation material, but this was only used occasionally within particular topics, and not observed within our study. Some science tutors expressed the belief that ICT was a distraction from the practical nature of their subject, and there was seen to be an issue of conflict for accommodation between labs and computer suites. Many of the maths and science teachers had received little, if any training in iWB use and were unaware of what contribution they could make to teaching and learning in their subject areas.

Health and social care courses and vocational courses had significantly less whole class teaching than science or maths, and were characterised by more group work and use of individual computers in class. So although iWBs were used regularly this did not necessarily take up a large part of the session. In some health and social care and vocational classes iWBs were used for introductions and summaries to sessions or for small group presentations and discussions. In others they were used more intensively, for example to demonstrate new skills or concepts, such as analysing performance in sports studies.

In all subject areas we did see some good teaching and learning sessions in which iWB played little part. In these cases there was generally a lack of access to facilities or training for the tutors.

As the case of the maths tutors has demonstrated tutors' awareness of the possibilities of iWB use within their subject area, and beliefs in the efficacy of ICT is crucial. The objectives of the tutor and their general pedagogic understanding and skills also influence use and outcomes. Outcomes were maximised where tutors aligned their use of the iWB with specific learning purposes, and made those purposes evident to the learners. For example one exceptional maths tutor teaching a reluctant group of re-sit students deliberately set out to entertain and cajole them into giving him their full attention, so that they could better understand and remember the points he was making. The tutor used the embedded software from the iWB, occasionally using graph paper backgrounds and particular geometric shapes, and drew and wrote on the board throughout his teaching, saving annotated screens to go back to in response to students' questions, or to reinforce a point. He used colour, highlighting and drawing in very well thought out ways, such as introducing unknown variables in algebra as coloured blobs. He got a lot of student participation, with some coming out to write on the board, and others discussing what should be done. The students were enthusiastic about the contribution made by the use of the iWB, and both the student focus group and questionnaires confirmed the impact that this form of teaching was having, particularly in relation to engagement and cognition factors. iWBs were only deployed effectively where the tutors possessed a sound understanding of generic and subject specific pedagogy. This, if combined with awareness of subject specific applications and resources enabled tutors to choose appropriate iWB uses to meet their pedagogic aims, and integrate iWB use into their overall repertoire of teaching approaches to maximise student outcomes.

Effects on intermediate outcomes were greater when a variety of ICT was used frequently. Thus the impact of iWB was enhanced when it was used in conjunction with e-learning activities, for example using the iWB to stimulate interest in class and then the students following this up through homework set on the VLE.

Contextual factors affecting iWB use and impact

The most immediate and obvious contextual effect on whether the iWB is used or not is the availability of equipment in the teaching room. However this is overly simplistic when the real time-constrained situation of the tutors is considered. Tutors needed easy access to compatible computers to prepare their iWB teaching materials outside the classroom, and often wanted particular subject specific software installed and available on the college system. They were generally prepared to plan iWB use into their sessions, but only where they had regular access to iWBs, particularly for all their parallel classes, so that only one set of preparation was required. All colleges failed in some of these minimum technical requirements, and in some, the simple layout of the teaching rooms inhibited use, where the students could not comfortably see the screen, or the tutor could not maintain eye contact because the computer was situated at the back of the room. Mobile units which required moving, setting up and calibrating before each session were underused because tutors had no time to set them up.

However, these immediate technical problems at the teaching interface were symptomatic of the whole college level of leadership and technical maturity. Each of the case study colleges was on a journey towards ICT maturity, but none at the time of the study had reached full maturity, despite the sample including three colleges that had been chosen because they were perceived by ICT experts to be leading the FE sector in ICT development. In most colleges between 50% and 63% of tutors in the study were using either iWBs or data projectors (table 6).

College A with 88% regular users (all using iWBs) and college B with only 22% regular users showed greatest variation from the average. Although at a surface level it is easy to attribute the lack of use of iWBs in college B to the fact that the boards were mobile and there were problems in setting them up, the differences between the colleges also represent a more fundamental difference in leadership maturity. We found a cumulative progression in maturity in colleges (Figure 2). The first stage focused on ICT for the management of learning, where the priority was enabling flexible learning, supported through access to materials and electronic support. This was followed by an emphasis on ICT in teaching in order to provide variety and interest, and then to predominant concern with ICT within learning and teaching, where the intention was to improve student understanding, involvement in learning and learning how to learn. In college B the predominant vision was on managing learning, so purchasing high specification computers for students use and developing a very effective VLE for easy access to resources and efficiency in sharing resources had been prioritised. The ICT leadership vision in College A took into account of all three strands with a priority on using ICT to support learning. This in turn led to more equipment in the classroom and more highly developed training and support for tutors. In all colleges the focus of the leadership vision was generally understood by most of the tutors. Many tutors echoed these when asked about their own purposes in using, or not using ICT within their teaching. Both of the maths tutors in college A made interactive use of the iWB, but maths tutors from colleges with a less mature ICT leadership vision tended to lack awareness of the potential of the iWB to aid cognition and could therefore see no point in using it.

Differences in the availability of iWBs across colleges departments also emanated from limitations of the physical infrastructure of some buildings, and from historical factors in the college's development, particularly where faculties or sites had had considerable historical autonomy in the recent past. In colleges with a less mature ICT vision faculty and department heads were influential in securing resources for ICT and creating expectations on staff of ICT use. If an individual department head was not convinced of the value of ICT, (as happened in some science and maths departments) their teaching rooms were generally less well equipped and tutors did not perceive any strong expectations of ICT use.

Much of the iWB equipment and projection facilities in the colleges had not been there for very long, and the limited use of the interactive facilities could often be ascribed to the limited training they had been able to obtain. While all the case study colleges provided training to develop tutors' technical ICT skills and short generic training in iWB

Figure 2: Leadership maturity in FE colleges: how leadership focus influences ILT use and development

Leadership focus	Management of learning	ILT in teaching to provide variety and interest	ILT within learning and teaching
vision	enabling flexible learning, supported through access to materials and email support	improving student motivation and attendance and encouraging their independent work through VLE links	improving student understanding and involvement in learning – and learning how to learn.
priorities	student access to computers of high specification, and to the VLE	interesting and varied teaching - in rooms equipped with projectors and internet access	interactive use of relevant ILT to make the subject more accessible to the students (using iWB, sets of laptops, tablet PC etc)
action	staff put materials on VLE for students to access and/or give information on internet sites Students use for coursework, assignments and revision; Sharing materials between staff.	staff provide varied sessions including web demonstrations, PowerPoint presentations, quizzes	class and group use of iWB and laptops to investigate; solve problems and use visualisation, simulations, role play etc of direct relevance to the subject being taught. VLE used to store and give access to learning processes and outcomes
 increasing maturity (earlier uses are subsumed within later uses)			
weakness	neglects pedagogy; problem with staff access to computers if priority is given to the students unless specifically included in the course, students rarely access VLE materials	teaching can become repetitive because onus on staff to come up with new presentations ILT can be overused or used where it is not the most appropriate tool	some staff are unaware of the uses within their subject area, and also need time to prepare materials; heavy demand for equipment in teaching rooms

use, there were more limited opportunities for tutors to gain training in how to use the iWB to enhance learning in their subject areas. This combined with a lack of time to work collaboratively with colleagues to develop approaches relevant to their subjects meant that many tutors were unaware of software relevant to their subject and the possibilities for interactive use that aligned with the objectives for their subject. Many departments lacked role models who had a good understanding of how ICT could be used to greatest effect within their subject area. Nearly all the tutors who were at the forefront of effective iWB use had gained some of their knowledge from external contacts and sources.

Technical maturity tended to follow the vision, as financial support was given to the leadership priorities. As would be expected regular access to iWBs, easy access to equipment for tutors to prepare materials, together with a speedy technical response and a clear system for requesting help all led to greater iWB use.

Conclusions and Implications

The colleges in this study were at an early stage in the development of iWB use. The progression described in schools literature of early preoccupation with getting to grips with the technology and focusing on the quality of presentation and motivation, moving towards a greater focus on pedagogy (Glover et al., 2005), was clearly evident. Most tutors were at the early stages of (Somekh and Haldene, 2005)'s typology of tutor skill levels, their approach being characterised by pedagogic exchange.

There was evidence of impact on student intermediate outcomes. Students' acquisition of knowledge and skills were enhanced through using iWBs as a presentation tool (ELU: B1, B2 and B3) to engage learners, thus making them more receptive to learning, and cognition was facilitated through interactive presentations (ELU: B2), student presentations (ELU: B3), and use of problem solving/learning tools (ELU: C2, C3). Tutors who planned learning with the intention of developing autonomy, used the iWB interactively during class sessions with subject-specific software (ELU: B2, B3 and C2) alongside a range of other ICT uses to change students attitudes, aid cognitive gains and develop learners' capacity for autonomous learning. The impact of iWB or data projector use was maximised when tutors aligned its use with specific learning objectives, and had a good pedagogic understanding of both generic teaching and learning and of their subject, so they were able to integrate use appropriately into their teaching. Effects on intermediate outcomes were greatest when there was frequent purposeful use of a variety of ICT tools, so IWB use was linked to other ICT activity. Within the scope of the study it was not possible to identify direct links between iWB use and student retention or attainment.

The study raises issues both for future research and for the development of iWB use, and ICT more generally, within colleges. The finding that student outcomes appear to be most significant when a variety of ICT uses are deployed in alignment with specific learning objectives and within a framework of developing autonomy signals a need for

more research focused on the interplay of ICT tool use in student outcomes, and the relation between this and tutor intentions. Cox et al.'s (2004) review of research literature on ICT and attainment found very few published studies on school teachers using a wide range of ICT resources in their curriculum. Better understanding of the combined use of a range of ICT tools in teaching is particularly important for the college sector where the mode of study is more diverse than in schools, often including a higher proportion of individual or small group directed study that is not necessarily supervised by the tutor.

Colleges, and those supporting ICT use in colleges, need to be concerned at tutors' lack of awareness of the potential of iWBs to support student learning in their subject. This lack of awareness in turn affects tutors' beliefs in the efficacy of using the technology, which directly impinges on whether or not they choose to use an iWB , and if they do the purpose for which it is used, and therefore ultimately student outcomes. There was overwhelming evidence from the case studies that there were four critical conditions for ICT use in general, each of which clearly apply to iWB use:

- There is adequate ICT equipment available.
- Tutors are aware of how to use ICT effectively to support learning and teaching in their subject, and the range of resources that are available to support this.
- Tutors are allocated time to individually and collaboratively develop their ICT practices and resources.
- Tutors' general pedagogical understanding and practices are sound.

Leadership maturity is crucial to effective iWB use. It is only colleges who prioritise ICT as a tool to support learning that make significant progress in ensuring that appropriate equipment and software is available, and create the conditions that allow tutors develop a pedagogically sound understanding of how to deploy iWBs in their subject teaching.

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