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Interactive whiteboards: Real beauty or just "lipstick"?

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Abstract

There has been extensive investment by governments and individual schools in interactive whiteboard technology in developed countries premised on the assumption that their use in education will impact positively on learners' achievements. Developing countries, such as South Africa, keen to raise attainment among their learners are following suit. While at least one of the nine provinces in South Africa had undertaken pilot roll-outs of interactive whiteboards (IWBs) in schools, the Eastern Cape Department of Education commissioned a feasibility study to determine teachers and learners perceptions of the potential benefits and drawbacks of using interactive pen technology, specifically the eBeam, in their teaching and learning environments, before embarking upon a large scale roll-out. This paper reports on a case study of three government schools and highlights the learners and teachers' enthusiasm about the "big screen" and the multimedia options, but also raises concerns about the lack of ICT literacy displayed by teachers and learners and the cost of technology. As most of the benefits mentioned by the teachers and learners seemed to accrue to the use of the laptop and data projector combination and most of the drawbacks emanated from the use of the interactive pen technology itself, we suggest that it may not be expeditious to attempt to "leap-frog" the use of interactive technologies. Instead we suggest that an evolution of ICT related pedagogy is necessary to make optimal use of interactive pen technologies such as the eBeam and that teachers should be offered technologies, not have them imposed upon them.

Keywords: Interactive whiteboards; Interactive pen technology human–computer interaction; Improving classroom teaching; Interactive learning environments; Interdisciplinary projects; Teaching/learning strategies

1. Introduction

There has been extensive investment by governments and individual schools in interactive whiteboard technology in developed countries. In UK the government has invested huge amounts of money in interactive whiteboards (IWBs), "in the belief that their use in the educative process will raise attainment among British school children" (Hall & Higgins, 2005, p. 102).

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Numerous studies have been undertaken to investigate the use of interactive whiteboards (IWBs) in classroom environments in developed countries. These studies address the issue from a variety of angles: some focus primarily on the use of IWBs in particular subject areas (Merrett & Edwards, 2005; Glover, Miller, Averis, & Door, 2007); others focus on teachers' perspectives (Loveless, 2003; John, 2005); and still others focus on the learners' perspective (Hall & Higgins, 2005; Wall, Higgins, & Smith, 2005).

Teachers report on the efficiency, flexibility, versatility of an IWB and the opportunity to access multimedia content, as well as the ability to manage the class more easily while using an IWB. Teachers viewed the efficiency of an IWB as a major advantage, referring to the ability to seamlessly access one resource after another from the board (Glover & Miller, 2001). A related benefit was the flexibility and versatility of the IWB as a teaching tool to allow teachers to support multiple needs within one lesson (Miller & Glover, 2002). Related to this is the opportunity for teachers to draw from countless multimedia sources, a frequently reported benefit of IWBs (Glover & Miller, 2001; Levy, 2002). Finally, one of the major advantages of an IWB is the ability to face the class whilst teaching (Smith, 2001; Wood, 2002) which allows teachers to maintain class control and, as reported by Wood (2002), to be more in touch with the learners by maintaining eye-contact than when using a laptop.

In a recent study, of learners perceptions on the use of IWBs in their classrooms, Wall et al. (2005) found that learners saw IWBs as effective tools for initiating and facilitating the learning process, in particular when they were given the opportunity to use the IWB themselves. The learners also commented on the visual nature of the IWB, frequently referring to the different ways information can be presented which was seen as a way to reinforce concentration and attention. Finally, the learners pointed to their teacher's lack of ICT skills, associated cost of IWB technologies, and the technical reliability of the IWB as disadvantages of the technology. It is important to note that in all these studies there is a high level of ICT integration in the teaching and learning environments already. According to BECTA's survey of ICTs in primary, secondary and special schools in England (Prior & Hall, 2004), over 99% of all schools have computers for teaching and learning and are connected to the Internet. Also, 84.3% of teachers in England (across primary, secondary and special schools) regularly incorporate ICTs in their teaching and learning environments (Barker & Gardiner, 2007).

Developing countries, such as South Africa, are eager to accrue similar benefits of using ICT technology, including interactive whiteboards, to improve the levels of engagement and hopefully achievement among learners. The Western Cape Education Department, one of the nine provinces in South Africa, has already undertaken pilot roll-outs of interactive whiteboards (IWBs) in schools (Walker, 2006 personal communication). In the Eastern Cape Province, only 4.5% of all schools have computers for teaching and learning (Department of Education, 2003). The Eastern Cape Department of Education (ECDoE), which manages one of the poorest provinces in South Africa, was eager to establish the possibilities of using IWB technologies to "leap-frog" the teachers and learners into using ICTs to enhance teaching and learning. The underlying assumption being that if a laptop and an IWB could provide the necessary support to teachers and learners this would be a much cheaper option for the cash-strapped ECDoE to roll-out to all schools. The ECDoE was therefore particularly interested in determining teachers and learners' perceptions of the potential benefits and drawbacks of using IWBs, specifically the eBeam (Luidia Systems, 2007), which is a cheaper and more versatile version of the traditional interactive whiteboard (such as the Promethean and Smartboard) and uses "interactive pen" technology.

The eBeam technology consists of two pieces of hardware: a receiver that is placed on the edge of the flat surface such as an ordinary whiteboard, and a radio-wave emitting pen. When the pen is pressed on a hard surface, such as a whiteboard or a table, it emits a radio-wave which is used to determine the pen input position with respect to the receiver. The input from the interactive pen is transformed into a mouse event and sent to the operating system to process. In this respect, the interactive pen is similar to an IWB except that in the latter the projection surface itself calculates the position of the input, while in the former the laptop to which the receiver is attached, calculates the position of the input. An additional benefit of the eBeam is that it is portable, unlike the mounted interactive whiteboards and can be used on any flat surface.

According to a study in UK by the Joint Information Systems Committee (JISC), IWBs cost anywhere between 2 and 4.5 times as much as interactive pen technologies (Brown, 2003). Although there is a substantial price difference, superficially there seems to be little difference between the functionality offered by the two technologies. Both technologies offer comparable functionality: handwriting recognition software; drag and

drop functionalities; and other related tools (displayed on a tool bar) such as the ability to change input modes from annotation to mouse events. Brown (2003) notes that the primary differences between the IWB and interactive pen technologies are reliability and portability. Brown claims that interactive pens can be less reliable than IWBs as they may not pick up every stroke that is made. He does point out, however, that interactive pens are inherently more portable than IWBs as they are created to augment any flat surface.

The ECDoE requested a team of researchers from the Computer Science and Education Departments at Rhodes University to undertake a feasibility study to investigate teachers and learners' perceptions of the potential benefits and drawbacks of using IWBs – specifically the eBeam (Luidia Systems, 2007) technology in three schools as a way of encouraging evidence-based policy (Pawson, 2004) and evidence-based practice (Cordingley, 2004). The researchers were somewhat hesitant about the idea of "technology transplantation", given the dearth of other ICT infrastructure and experience in the Eastern Cape schools. Tedre, Sutinen, Kähkönen, and Kommers (2006) argue that technology transplantation does not always work, and point to technological determinism as a flawed view of the role of ICT in society. Stated simply, "the technology that is best from one point of view is not necessarily best from another" (Tedre et al., 2006, p. 128).

In a previous article, derived from the same research (Slay, Sieborger, & Hodgkinson-Williams, 2007), we demonstrated that successful integration of IWBs into teaching and learning environments required a shift in the pedagogical practices of teachers. This article differs from our previous work in that it presents a comprehensive review of both the teachers and learners opinions on the usefulness of eBeams compared to the usefulness of a laptop–data projector combination. It identifies the six most cited factors by teachers and learners in the use of the eBeam: visibility of the big screen; lack of ICT literacy and competency; value of multimedia content; motivational use of up-to-date technology; interactive affordances; and cost.

2. Research design

The main research question that the team sought to address was how and why do interactive pen technologies, such as the eBeam, enable or constrain teaching and learning in South African primary and secondary schools. In order to answer the main question, the following subsidiary questions were posed:

- What benefits and drawbacks do teachers perceive when using interactive pen technologies in their teaching?
- What benefits and drawbacks do learners perceive when using interactive pen technologies in the classroom?

As our guiding principle we followed Pawson and Tilley's realist maxim of research design which is to "produce more detailed answers to the question of why a program works for whom and in what circumstances" (Pawson & Tilley, 1997, p. xvi). Our research design decisions which will be presented in this section include: determining the research methods we would use to elicit responses from the participants; selecting the sites for the piloting of the eBeams; identifying the teachers with whom we would work; and selecting techniques for capturing the research data. We then discuss how we analysed the data collected during the study, followed by an overview of each of the five case studies that we observed.

2.1. Methodology: case study

While framed as a feasibility study for the ECDoE, the research can be broadly construed as a case study. Robson defines case study methodology as "a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon in its real life context using multiple sources of evidence" (1993, p. 52). Adopting this case study approach enabled us to focus on what Erikson maintains is a key strength of a case study, namely that it "enables the uncovering of events or processes that one might miss with more superficial methods" (Erickson, 1986, p. 238). Case study research does have its drawbacks in that it cannot be easily generalized, but if it is "contextualised and carefully described. . .then others can consider its usefulness in other contexts and examples" (Wisker, 2001, p. 191). In fact social realist research, which underpins our thinking in this study, explicitly holds that:

> No individual-level intervention works for everyone. No institution-level intervention works everywhere. The net effect of any particular programme is thus made up of the balance of successes and failures of individual subjects and locations. What this points to is the need for a careful look at subject and contextual difference in terms of who succeeds and who fails within any programme (Pawson, 2004, pp. 30–31).

Our reporting therefore does not claim to generalise, but does attempt to highlight issues that have either positively or negatively influenced teachers or learners use of IWBs. As Pawson explains: "At the extreme, we can still learn from a negative net effect of a single evaluation study, since the application of an initiative to the wrong subjects and in the wrong circumstances can leave behind vital clues about what might be the right combination" (2004, p. 31).

2.2. Sites and participants

The Grahamstown area was chosen as it is close to Rhodes University where the research team is based, and because recent studies by the research team had enabled us to establish the necessary relationships with the school principals and teachers to be able to conduct a study of this nature. Three schools took part in this feasibility study: one former House of Representatives (HoR) primary school; one former HoR secondary school; and one former Department of Education and Training (DET) secondary school. One of the features of apartheid was that South African schools were separated (and funded) according to race (National Education Policy Investigation, 1992; Howie, Muller, & Paterson, 2005). When South Africa became a democratic nation these state school classifications fell away. The disparities of the past, however, still have a large affect on these schools today: former DET schools (previously black only schools) and former HoR schools (previously coloured only schools) tend to be more disadvantaged than former House of Assembly (HoA) schools (previously white only schools). These schools were selected as the ECDoE was interested in the perceived benefits and drawbacks of IWBs in previously disadvantaged government schools.

The three schools were chosen according to the key criteria that emerged from literature and from other studies that were recently conducted in the same area (Maholwana-Sotashe & Hodgkinson-Williams, 2005; Mbane & Hodgkinson-Williams, 2005; Brandt, 2006). These criteria include the necessity of suitable ICT facilities; Internet connectivity; teachers' prior experience of using ICTs in the classroom; and supportive school principals.

In order to undertake this feasibility study, the ECDoE supplied one eBeam interactive pen system (the pens, the receiver and a digital eraser), one laptop and one data projector to each school. Each teacher was supplied with one standard whiteboard to be mounted in their classroom, as all of the schools still used blackboards. As the ECDoE was contemplating purchasing only one eBeam per school, the researchers needed to explore not only how teachers could use IWBs in their individual classrooms, but what logistical issues might enable or constrain the optimal use of eBeam technology across at least three classrooms. Consequently three teachers participated from the former DET secondary school in order to enable an investigation into the advantages and disadvantages of the mobility of the eBeam unit. One teacher participated from the former HoR primary school and another from the former HoR secondary school.

Prior to the study, permission was granted by the local district office and subsequently each principal, teacher and learner signed a consent form. To ensure that teachers were provided with adequate training with the new eBeam technology, four 2-h training sessions were held prior to the start of the study. The first session was held at a local independent school that had recently purchased an IWB and a teacher, familiar with IWBs, demonstrated its use to the group of teachers, their school principals and researchers. We assumed that it would be useful for teachers to observe how IWBs are used in a classroom situation before endeavouring to use a similar technology themselves. In subsequent training sessions, teachers: learned how to assemble, calibrate, and disassemble equipment; were given basic instructions on presenting lessons with the hardware; and presented a demonstration lesson they had prepared for the other participants and researchers. Throughout the training, researchers observed teachers' ICT skills and attempted to provide additional support to those who were less familiar with ICTs.

After the training, teachers were interviewed separately in order to determine their formal and/or informal ICT training; their typical use of ICTs in the classroom; and how they thought they would use the eBeam in

their teaching environment. The average duration of each interview was 15–20 min, and followed a semi-structured interview schedule with a series of key questions that commenced with some reasonably non-emotive questions (to put the interviewees at ease) and then progressed to the more theory-laden questions. "Theory-laden" refers here to our theories as researchers of what we deemed to be, through our reading of the literature and through our own reflections, the potential benefits and drawbacks of using IWB technologies in teaching environments.

Over a period of four months, each teacher was visited at least three times, with each visit being observed (on all but two occasions) by two researchers. All classroom visits were scheduled at the convenience of the teacher. Observation sheets were adapted from previous studies (Orlando, 2005) in an attempt to standardize the recording of the behaviour observed in the classroom and to foreground the key issues. The observation sheet included a range of data recording techniques including: drawing the layout of the classroom; rubrics to judge the use of software; Likert scale type questions; and narrative comments. During the observations, photographs were taken in order to capture some of the visible constraints that both teachers and learners had to overcome in using the technology. Permission was sought for each photograph used in the presentation of the data.

On completion of their last observed lesson, each teacher was again interviewed to elicit their opinion on their experiences with the eBeam in their classroom. The average duration of each interview was 15–20 min and followed a similar process to that outlined in the description of the pre-observation interviews. As we were also interested in the learners' perceptions, 10 learners from one of each teacher's classes were selected to participate in post-observation focus group interviews. The learners were selected according to their availability and willingness to participate in the focus group (Robson, 1993; Schurink, Schurink, & Poggenpoel, 1998). We chose the focus group approach to encourage discussion amongst the learners as some of them may have felt to shy to comment on a one-to-one basis.

2.3. Analysis

All pre-intervention, post-intervention and focus group interviews were recorded using two 130° Shure Microphones and a SoundCraft Compact 4 Mixing Desk. Sound files were compressed to MP3 format using audacity and then transcribed verbatim by the researchers. Each interview transcript, field note and observation sheet was typed in Microsoft Word for later incorporation in the data analysis phase. Transcripts were coded to maintain anonymity of participants.

In an attempt to triangulate the data, we employed three of the four types of triangulation put forward by Denzin (1978), namely methodological, data and investigator triangulation. We used multiple methods to study a single problem (methodological triangulation); we elicited comments from various sources of data which included the teachers and the learners (data triangulation) and included the observations of three researchers (investigator triangulation).

Our primary methodological dilemma was deciding how to synthesize data that was collected from three different sources (teachers; students; and the observers) and from five different methods (field notes, interviews, observations, photographs and focus group interviews). The researchers were required to summarize this diverse and disparate information into a consistent, yet still information-rich format. Also, as the study was carried out by three researchers, another problem encountered was how to analyse qualitative data in a collaborative manner. The particular challenge was how to code transcripts of interviews and focus groups as well as the observation data in a consistent manner. These methodological dilemmas were to some extent overcome by the use of a qualitative software package, NVivo 7 (QSR International, 2007), which enabled separate, but simultaneous analysis by the researchers of the data from each school, but allowed for the use of common codes for comparison.

Qualitative data analysis involves some form of coding, either from a top–down or bottom–up approach or a combination of both. Strauss (1987) makes the distinction between sociologically constructed codes and in vivo codes. We primarily used in vivo coding or a bottom–up approach to the derivation of categories from the content of the data (Coffey & Atkinson, 1996, p. 32). However, at the beginning of the process some broad categories were defined by referring to related work, using a top–down approach. We made use of the constant comparative analysis (Glaser & Strauss, 1967) to analyse the interview transcripts and observation notes. Our

coding process began by collectively reading an interview transcript and coding it together. After completing one transcript together, the remaining transcripts were distributed and coded separately. To ensure that we could add additional codes, one researcher was designated as the "code boss" and all requests for additional codes were sent to her for approval. At regular intervals we would merge NVivo files into one, and redistribute it (with additional codes) to continue the process. Once all the coding was completed, reports were drawn from NVivo on the various themes that will be presented in the next section.

In order to preserve the anonymity of schools and teachers, their names have been coded and can be seen in Table 1. The remainder of this sub-section describes each of the teaching and learning environments, respectively, starting with Teacher A and finishing with Teacher E.

2.3.1. School 1

School 1 is a former HoR school and accommodates learners from Grade R to 7. The school was originally started by Anglican nuns in 1854 and offers tuition in the English medium despite the fact that most learners are not English mother tongue speakers. The school premises are very small, and consist of only four classrooms in the original wooden-floored building. In addition, the school rents a hall across the road which can accommodate another two classrooms – separated with "pre fab" walls. The school consists of 230 learners and nine staff members. It has five desktop computers and one server, which are networked within the school and connected to the Internet. Four computers are located in classrooms, with the additional computer being used for school administration purposes. The vice-principal of this school was very supportive of our research project, even attending and participating in the training sessions prior to the commencement of the observations.

Teacher A is a Grades 5, 6 and 7 English as a second language teacher, who teaches a range of learners who mostly speak English as their second or third language. Throughout the duration of the study, we observed her Grade 6 class which had an average of 29 learners. Some of the learners in this class struggle to read and write in English, often these children commenced Grade 6 unable to do either at all. The average age of the learners is 11 years, however, some of those learners who are unable to read are as old as 13. Teacher A has had experience in using ICTs since 1998. She began with a very basic computer literacy course that was run by a local outreach program, Teacher Aid Programme (TAP). Since then she completed her Advanced Certificate in Education in ICT course through Rhodes University (a 2 year diploma course for in-service teachers). Teacher A's classroom contains one Pentium 2 computer that can either boot Windows'98 or can boot as an Edubuntu Linux thin client from their central server. In Fig. 1, learners can be seen writing their homework on the whiteboard using the eBeam interactive pen. The eBeam receiver is just visible on the lower left hand side of the whiteboard. When used in this mode, pen strokes are captured and can be saved on the laptop.

The sequence of lessons observed in Teacher A's classroom focused on the reading of an interactive (flash) story of Goldilocks and the three bears. The interactive story included both voice and video in its presentation. In the first lesson, the teacher and learners read along with the story, with each learner taking a turn at reading a page aloud from the board. They were then given a worksheet on prepositions and took it in turns to identify the prepositions on each page. Learners were then given a group exercise to complete on prepositions, and each group had the opportunity to report back to the class by writing their answers on the whiteboard using the eBeam interactive pen. In the second lesson Teacher A taught the learners about the various components of a story, using the Goldilocks story as a point of reference for the learners. A small number of the class were then asked to tell a traditional story that they knew to the rest of the class which they were then able to use as

Table 1
School and teacher code names

School	School code	Teacher code
Primary school 1	School 1	Teacher A
Secondary school 1	School 2	Teacher B
Secondary school 2	School 3	Teacher C
		Teacher D
		Teacher E

Fig. 1. Learners in Teacher A's Grade 6 class using the IWB to capture pen strokes.

other examples for analysis. Learners were then, in groups, asked to research endangered bears. Groups took turns using the laptop (with Encarta) and the other computer in the classroom (with an Internet connection) to undertake their research. While waiting their turn, learners were given a task to produce a newspaper containing an article about Goldilocks and the three bears and a piece of new information about bears that they had discovered through their research. Each group then read out their newspaper articles to the rest of the class. While the groups presented Teacher A made notes about each group's work on the whiteboard so that the eBeam could capture her notes and she could save them for later use. In the final lesson, learners again took turns in reading a page aloud from the board which displayed the interactive online story of Goldilocks and the three bears. After reading, the learners were asked to identify the nouns on each page. Once correctly identified Teacher A would circle the noun, using the eBeam annotation feature, to ensure that all the learners knew which words were the nouns. Learners were given a picture and in their groups needed to identify all the nouns in the picture. Each group was then asked to select two students who wrote down the list of nouns they had identified on the whiteboard. The eBeam was used again to capture what the students had written and saved to a file for the teacher to use in later lessons and to award marks to each group. Teacher A then used MS Word to present notes to the learners about nouns and proper nouns. To reinforce this new knowledge, she gave each group a short story and again they needed to identify the nouns, but this time the pronouns as well. Once again each group wrote their answers on the whiteboard and the teacher captured the work. Finally the learners were each given a worksheet that they needed to complete individually about nouns and pronouns.

In the first two lessons, learners were very engaged in the class. In the third lesson, however, students were mostly enthusiastic, but several were quite disruptive. This may be due to having outsiders watching the class (the observers), but it also could be due to the fact it was the end of the term. The teacher successfully incorporated the eBeam into her teaching, using it as one component (not the only component) of the lessons. Teacher A's excited attitude towards the use of the eBeam seemed contagious, as the learners were all excited to participate and present their work to their peers using the eBeam interactive pen. Most technical problems that

occurred during the study were solved by the teacher or learners themselves, with the researchers having to provide brief assistance only once.

2.3.2. School 2

School 2 is the first of the two secondary schools that took part in this investigation, and is also a former HoR school, with 1180 learners and 32 teachers. School 2 is equipped with two computer labs: the larger one is a tuXlab (Inkululeko Technologies, 2006) which consists of 20 thin client computers (Pentium 2) which boot off a tuXlab server; and the smaller Dell lab consists of 18 dual boot (Windows XP/Ubuntu Linux), thick client machines (Pentium 4), and an Ubuntu Linux server.

One teacher took part in the study from School 2, namely Teacher B, who teaches English and Life Orientation. We observed his Grade 11 English class, where the average age of the learners was 17 years. Teacher B has been exposed to computers since 1988 when he was at secondary school. While he has had no formal training, he worked in the corporate sector prior to teaching and undertook in-house training, often having to give presentations as part of his work. Through owning his own computer, and benefiting from many years of ICT exposure in the corporate world as well as having access to computers at his school, he has been able to teach himself how to use computers. However, prior to the eBeam study his integration of ICTs into his teaching was minimal, and limited to occasionally allowing learners to use computers to undertake research on some of their literature topics in his English classes. Teacher B's English class had the largest class size of all those involved in the study. At its peak, there were 54 learners in the one small classroom. To accommodate all the learners, more than 10 were seated with their backs to the board and were required to continually turn around to be able to participate in the class. An additional four learners were seated on the floor in front of the first forward-facing row depicted in Fig. 2. As well as impacting on the amount of personal attention each learner could expect, this large class also meant there was no room to position the data projector correctly. Instead, the projected image only took up 60% of the available board height, resulting in a small image that was not always decipherable to the learners seated at the back of the class (as can be seen in Fig. 2).

Fig. 2. Teacher B's Grade 11 English class students seating arrangements.

In the first lesson, Teacher B used Microsoft PowerPoint and Acrobat PDF Reader to discuss the linguistic techniques used in advertising. He commenced the lesson by going through prepared slides on different linguistic techniques, and then worked through an example on the whiteboard using the eBeam's annotation mode to write down answers that the learners called out (Fig. 3). Students were then given an exercise to complete in groups, and report back their findings to the remainder of the class. In the next lesson, Teacher B used PowerPoint to illustrate rhyming schemes of sonnets, including hyperlinking to definitions of new poetry concepts. At the end of the presentation, he had included a poem in which the learners were required to work out the rhyming scheme. Learners took turns to use the eBeam interactive pen to annotate the rhyme scheme on the PowerPoint slide. During this lesson, learners seemed to struggle with the concept of digital ink, attempting to erase mistakes using their non-dominant hand, instead of using the digital eraser (which works on the same principle as the interactive pen but has a physical whiteboard eraser attached). The final lesson that we observed was a revision of the advertising section from the first lesson. This lesson followed a similar structure to the first lesson we observed. During this lesson it was easy to notice how Teacher B was able to spend more time interacting with the class and less time interacting with the board as opposed to interactions with a traditional chalkboard.

2.3.3. School 3

The second secondary school involved in this study is a former DET school which consists of 600 learners and 20 teachers. The school comfortably accommodates one large computer lab, with computers that are either old Pentium 1 computers which boot Windows'98 or newer Pentium 4 computers which dual boot Windows XP and Edubuntu Linux. The school has a FreeBSD server which provides file sharing, mail, web space, domain and internet routing services. The principal of this school was very supportive of our research project.

Three whiteboards were installed in this school, one per teacher. The participants chose to have the whiteboards mounted in the computer lab, Teacher C's classroom, and Teacher E's classroom. As a result of not

Fig. 3. Teacher B's use of IWB in his Grade 11 English class.

having a whiteboard mounted in her classroom, Teacher D either used the computer lab or Teacher E's classroom when employing the eBeam in her teaching. Somehow during installation, each of these boards was installed incorrectly, creating a lump in the centre of the whiteboard surface. As the eBeam calculates positions by sending an infrared signal from the eBeam pen to the receiver on the side of the board, this "lump" affected the accuracy to which the pen position could be calculated. Each of the three teachers from this school therefore experienced technical difficulties with the eBeam related to this inaccuracy. The activities of each of these three teachers will now be discussed separately.

2.3.3.1. Teacher C. Teacher C is an Economics, Business Economics and Business Studies teacher. Throughout the duration of the study, we observed her Grade 11 Business Economics class, where the average age of her learners was 17 years. Thirty four learners attended her class which was held in the school's computer lab during the user study. Teacher C received ICT training initially from the Khula project (Whitlow, 1998a, 1998b) and then through attendance of SchoolNet courses (SchoolNet South Africa, 2003) and Intel Teach to the future (Intel Education, 2007). After this she completed a Masters in Education (Information Technology) at Rhodes University. Prior to the study, this teacher mainly used computers for administration purposes, although she also incorporated ICTs into her learning environment by taking her students to the computer lab to undertake research. More recently, and prior to the beginning of the study, this teacher revealed that she began using a laptop and data projector in her class.

Throughout the three lessons we observed, Teacher C addressed a common theme of analysing existing businesses in South Africa, regarding their business structure and policies. In the first lesson, Teacher C presented the economic theory using an elementary PowerPoint presentation. The learners were then given an assignment where each group had to research one South African company. She presented the assignment rubrics using Microsoft Word. The learners were asked to present their findings firstly using freemind (a freeware mind-mapping tool), and then use PowerPoint on the whiteboard to the rest of the class. These presentations were to take place in subsequent lessons. In lesson two, the learners continued with their online research, and then presented their mind-map on the whiteboard to the remainder of the class. This interim step was used so that Teacher C could determine if the groups were on the right track. Once completed, learners worked on a PowerPoint presentation based on the mind-map that had been approved by Teacher C. The final lesson consisted of each group giving their presentation to the class on the whiteboard. When using the eBeam, Teacher C generally used it as a replacement for the mouse; to click through her PowerPoint slides. However, occasionally she would make use of the annotation features of the eBeam software in order to annotate the answers that students gave onto her existing slides. Learners, however, only used the eBeam pen as a substitute mouse when presenting both their mind maps and their PowerPoint presentations to the rest of the class. Across all lessons, Teacher C encountered calibration difficulties due to her badly mounted whiteboard. This negatively impacted her teaching as she then spent time concentrating on getting the technology to work rather than on teaching her class.

2.3.3.2. Teacher D. Teacher D is an English, History and Life Orientation teacher. During the course of the study we observed her Grade 9 English class, which consisted of 30 learners who were about 15 years old. Her first experience of computers was during her Higher Diploma in Education (HDE) where she received pre-service computer literacy training and again during her B.Ed. (Hons) where ICT was one of her electives. Teacher D claims that she integrates ICTs into her teaching by taking her students to the computer lab to do research, although this is undertaken infrequently. Throughout the duration of the study, Teacher D's English class was held in either the computer lab or Teacher E's classroom.

In the first lesson, Teacher D used MS Word to work through examples of concords with the class. She started by opening a blank document and tried writing sentences on the board. As her handwriting was very untidy, the handwriting recognition software kept identifying the strokes as the wrong letters. Eventually one of the observers was asked to correct the sentences using the laptop's keyboard. Once sentences were written on the board, students took it in turns to correct the concords by coming up to the whiteboard and using the pen to correct the sentences. Learners seemed to struggle to understand that the whiteboard displayed the image from the computer using the data projector and often would stand in the path of the projected image and then not understand why they could not see their recent writing on the whiteboard. In these instances their

writing would be projected on the back of their shirts, and distract the other learners. In the second lesson, the teacher took 15 min to set up the hardware for the class, even though the laptop and data projector were already connected for her (she used the same classroom as one of the other user study participants). After struggling for a few minutes she realised she had forgotten the eBeam unit itself so asked a student to fetch it, along with Teacher C. When the hardware was finally configured, two learners were dispatched to collect the learners' exercise books that the teacher had also forgotten. While the two learners were away the teacher set up the software required for the lesson. This task took 12 min to complete, although it only consisted of double clicking on two icons on the laptop's desktop. When the class finally started, the teacher only had time to go through some sentences on the board. In the last lesson, the teacher decided to use the projector without the eBeam. She used MS Word again to show different road signs. Learners took turns to recognise the signs and call out their meaning. Ten minutes before the end of the class, Teacher D decided to set up and calibrate the eBeam, only to dismiss the class when she had finished the process.

Throughout all observations, Teacher D was very unsure of the technology, and seemed unprepared for the classes. It was curious to note that in the first lesson, Teacher D was very confident and competent at setting up the eBeam hardware. As time progressed, however, she seemed to get progressively worse at this task. From a technical perspective, both Teacher D and the learners kept pressing the button on the pen by mistake thus engaging the right-click option. The teacher also did not seem to grasp the different modes that the pen could be used in: as a mouse, or as a scribe. Students had immense trouble with the handwriting recognition software, but the teacher seemed not to realise that this could be turned off. For example, the students seemed to form letters using their own techniques. As the handwriting software works by analysing strokes, it would interpret a circle stroke followed by a vertical line stroke as "Ol" as opposed to a lowercase "a", which caused great mirth, but distracted from the focus of the lesson.

2.3.3.3. Teacher E. Teacher E is a Mathematics and Science teacher at School 3. We observed his Grade 11 Mathematics class, where there were 22 learners enrolled in the class. Teacher E had been exposed to computers since 1990, although in the earlier years he did not use them for teaching. Prior to the beginning of the study, this teacher used computers in his Mathematics class to help teach algebraic and trigonometric graphs. The only ICT training Teacher E had received was through the Khula project (Whitlow, 1998a, 1998b).

In the first lesson, Teacher E taught quadratic equations to his class using Microsoft Excel. He made use of the eBeam pen to enter in data to his spreadsheet and to change values in the spread sheet and then calculate the corresponding graphs, employing the use of the pen as both a mouse and scribe (a pen for writing). He used this software package to illustrate the effects of changing constants and variables in his equations and replotting the graphs to demonstrate the outcome. Learners seemed to respond positively to this lesson, as they were able to visualise the shift in the graph and correlate it with the change in variables. This lesson was negatively affected by the poorly mounted board which resulted in calibration problems. Eventually Teacher E gave up on using the eBeam and just used the laptop directly, after which the flow of his lesson improved. In the second lesson, Teacher E used PowerPoint and Word to teach the learners about rational and irrational numbers. He switched between PowerPoint and Word, using PowerPoint to provide the theory, and Word to demonstrate examples. In this lesson, Teacher E had only attempted to use the eBeam pen as a mouse to navigate through already prepared slides and worked examples. Teacher E's lesson seemed to be crippled by the inaccuracies of the poorly mounted whiteboard in his classroom, which eventually resulted in him asking one of his learners to control the software directly from the laptop on his behalf.

3. Findings

This section presents the opinions of the teachers and learners from each of the schools according to the key factors that they mentioned throughout the pre and post observation interviews and focus groups. Each point has been related to existing research to show how our findings relate to the existing body of research in this field. These factors are presented in order of the most frequently cited factor to the least frequently mentioned factor: the visibility of the big screen; the lack of ICT literacy and competency; use of multimedia content; use of up-to-date technology; interactive affordances; and cost. The last subsection concludes our observations by

showing the teachers' and learners' overall preference across all classes between an eBeam and a laptop–projector combination.

3.1. Visibility of "big screen"

The most frequently mentioned advantage by the teachers and the learners during this study of the eBeam was that it had a "big screen". Although participants viewed this as an advantage of the eBeam itself, we see this as a conflation of its attributes. We attribute this advantage to the projector, rather than the eBeam itself. These results are aligned with those described in a study by Wall et al. (2005) that found the improved visibility of classroom content was mentioned by learners more than twice as often as any other characteristic of IWBs. Their study also found that the visual aspects of IWBs are most valued (as compared to auditory, verbal-social and kinaesthetic) by learners. This finding is increasingly important for schools in the Eastern Cape, as they are typically under-resourced, with teachers having to make do with the minimal ICT infrastructure that is available to them. Previously in Teacher A's class, when she wanted to illustrate a concept on the one computer in her classroom, she would either have her 36 learners crowded around the one machine, or would break the class into groups of 6 and allow the groups to take it in turns to use the computer. These methods were ineffective and wasted valuable time. Now, she simply turns on the projector and can demonstrate concepts simultaneously to the whole class. Teacher A's learners commented on the benefits of a "big screen" on four separate occasions in their focus group interview.

As well as being beneficial generically across all subjects, Teacher E's Math class found the big screen to be particularly advantageous. When one of the learners in this class was asked what benefits she could think of, she said:

> Learner: It's that we could see the things. You see, in a function in algebra you have the standard formula which is $ax^2 + bx + c$. That is the standard formula for quadratic functions. So we could actually see what effect a had on the graph and what effect b has on the graph immediately. So it wouldn't take a long time like when we have to sketch the graphs by hand. You can imagine that when you sketch a single graph by hand it takes a long time and then if you want to change the value of a you have to draw again to see the differences. So we could learn more things in a single period than what we would learn over like a week.

Teacher E also marvelled at the benefits of the big screen on his ability to teach, and the learners' ability to visualise complicated concepts. In referring to his trigonometry lessons, Teacher E said "...Even though I didn't give them lots of time to practice drawing graphs, when you talk about a sin/cosine/tangent curve, they know it. They sketch it with something they see in their minds, because it's been imprinted using the process of repetition in their minds". He reasoned that as he was able to demonstrate more graphs in a shorter period of time, he could use repetition to "make things stick".

The value attributed to the "big screen" by the teachers and learners suggests that a laptop connected to a data projector is a worthwhile investment. Moreover, it would seem that in this study the visibility afforded by the data projector supersedes the interactivity offered by the eBeam. However, as the eBeam was more difficult to set up and to calibrate than an interactive whiteboard, this finding may have more to do with the eBeam technology than interactivity per se. With reference to the value of visualisation, a BECTA report also mentions the value of an interactive whiteboard enabling "teachers to demonstrate in a clear, efficient and dynamic way" as learners " visualise the techniques or instructions, for example, they use the visual...stimuli to develop and reinforce their understanding" (BECTA, 2004, p. 3).

3.2. Lack of ICT literacy and ICT competency

The most frequently cited disadvantage by teachers and learners was the lack of ICT skills among the teachers. The fact that in-service teachers do not have sufficient ICT skills is one of the largest ICT-related problems facing schools in the Eastern Cape (Department of Education, 2003). Teacher B commented on this skill deficit in his school, saying:

> If I think about it carefully there is still a huge resistance and there are still some people who are quite scared of using the computers at school. Just today I was helping somebody with schedules and they kept on calling me and asking me questions like "how do I move down the screen?" . . .I mean, I can imagine that if they have a problem with just sitting in front of a PC then how much more uncomfortable they might be when trying to use all of this equipment.

Other teachers from Schools 1 and 3 also commented that some of their colleagues who are not ICT literate tried to use computers, but became so discouraged by their failure that they have given up on using all ICTs. Hall and Higgins (2005) note that if teachers do not have sufficient ICT skills, this can result in poor use of the technology. Similarly, Sharma (2003) found that one of the most notable barriers to the use of ICTs in education is the low level of teacher ICT knowledge. Watson extends this perception by noting that "knowledge of ICT skills do(es) not mean these skills are always applied" (Watson, 2001, p. 255). Unless teachers practice the ICT literacy skills that they are taught, they will probably forget a great deal and lose confidence as well.

In some cases, teachers may be ICT literate, but not competent enough to apply the skills in their teaching and learning environments. In this work we understood "ICT skills" to mean that a teacher was able to switch on the computer and control the hardware, such as the ability to type or move the mouse and to make use of software available on a computer. "ICT competency" was understood as the teacher's ability to appropriately apply those skills in their teaching environment to enhance the quality of their lessons. Teacher C is a good example of this case. As mentioned above, this teacher had completed numerous ICT training courses (Khula project, SchoolNet courses, and Intel Teach to the future) in addition to a Masters in Education Information Technology. Although this teacher was competent and literate in general ICT skills, she did not seem competent with the eBeam hardware in particular.

Similar to findings in existing work, we noticed that learners were often acutely aware of their teachers ICT literacy shortcomings (Smith, Cowie, & Blades, 2004; Hall & Higgins, 2005). When Teacher C's learners were asked if they thought the eBeam helped her in class, one replied saying "Ja, I do think that it helped, but it made things a bit slow because she didn't really know how to use it". Later in the focus group the learners were asked if they thought it would be a good idea if the ECDoE left the eBeam in the class. The learners responded by saying:

> Learner 1: Yes, if they would first teach the teachers how to use it. . .
> Learner 2: They waste a lot of time in our periods trying to make it work and then we land up not learning anything.

These learners raised another related concern that if a teacher is not ICT competent, but still tries to incorporate ICTs into their teaching environments, it can actually detract from the learning experience.

When the teacher was both ICT literate and ICT competent, the eBeam allowed them to focus on the class rather than the content they were delivering. Take for example the case of Teacher B. Although he had no formal training in ICT literacy, he had been using computers since 1988 and had learnt all his computer skills informally. This literacy gave him the confidence to experiment with the use of computers, both for teaching and administrative purposes at school. In their focus group, Teacher B's learners commented that the eBeam was beneficial to their teacher "because he could pay more attention to us than writing on the board". As he could prepare material well in advance, he had more time in his class to interact with his learners rather than writing information on the board during the period. When asked how he thought the eBeam benefited his class he said:

> They benefited from the fact that firstly whatever resources we were using was much easier to get a hold of and to get into and then secondly there was a lot less hassle with having to write answers and clean the board and that whole repetitive schlep thing.

Clearly there is a need for teachers to be ICT literate, i.e. be able to use application software and the operating system as well as be able to connect a computer to a data projector before engaging with additional ICT equipment and its associated software such as the eBeam. Moreover, it is clear that completing ICT courses is insufficient unless the teachers continue to practice the skills acquired. Expecting teachers to be able to use the eBeam without sufficient basic computer literacy skills is counter productive and suggests that using the eBeam to "leap-frog" the use of ICTs in the classroom is questionable.

3.3. Value of multimedia content

The third most referenced factor was the advantage of incorporating multimedia content into the teaching environment. Throughout this study, teachers integrated numerous multimedia sources in their teaching, including: static images; Microsoft Encarta; online sources such as governmental websites; flash-based story books; PowerPoint presentations; Microsoft Excel; and Geometer's Sketchpad. Again, these findings are similar to those suggested by Hall and Higgins (2005), who found this to be one of the major advantages of IWBs in learning environments cited by primary school students. Wall, Higgins and Smith quote a student saying "the pictures help you to understand what the teacher is talking about" (2005, p. 860).

We found similar results from our own study, with learners often referring to the interesting and thought-provoking content. As mentioned above, learners from Teacher E's class went to great lengths to describe the benefits of being able to see the effect that changing a variable has on a graph. The primary school learners in Teacher A's class, and Teacher A herself, commented on the effectiveness of using Flash-based story books in class. Teacher A revealed that several of her Grade 6 learners are not able to read, but when the whole class was going through the online story books she said:

> Teacher A: I could see that they were trying to read along with the story. And afterwards when I tested them to see if they could read a line at least, I could see that they had improved. I'm not saying it's an alpha–omega or anything, but if they are exposed to it in all areas then I'm sure that it would benefit.

There is ongoing debate as to the reason behind the popularity of multimedia content on IWBs (Smith, Higgins, Wall, & Miller, 2005). Some refer to the IWBs ability to present information in vibrant colours, and the ability to move, manipulate, and zoom in on information as enhancing the learning process (Damcott, Landato, Marsh, & Rainey, 2002; Edwards, Hartnell, & Martin, 2002). Others link its popularity with its ability to display a wide variety of information so concepts become more tangible and therefore easier to grasp (Levy, 2002). Finally it is also argued that an IWB supports a wider range of learning styles, since teachers are able to draw on a variety of different resources to suit the learners needs (Glover & Miller, 2001).

In this study, it would seem that the teachers and learners attributed the benefits of multimedia to the eBeam itself whereas this feature is really a characteristic of the computer display rather than of the particular interaction device (e.g. eBeam, IWB, touch sensitive display). This suggests that for these teachers and learners interactivity per se did not seems as important as the multimedia display which could be more cheaply achieved by the use of a computer linked to a data projector.

3.4. Motivational benefit of sing of up-to-date technology

The fourth most frequently raised issued was the value of using of up-to-date technology. Most teachers involved in the study pointed out that their learners were attracted to the eBeam. One teacher, Teacher E, commented that to keep up with the times, teaching and learning should evolve to include whatever technologies learners relate to. He noted that if schools wanted to ensure that learners would attend class, they should become more relevant to them, saying:

> You know it's (the projector and eBeam) in keeping with the trend of things. Learners love to have technology – they relate to it. You know, the chalkboard and the learner, its kind of old fashioned. Although you can't divorce it completely, at least the eBeam brings the interest of the learner back into the class. The most impressive thing I see with the eBeam is that the kids relate to it, its technology, they have cell phones and things. They relate well to cell phones. When they see the eBeam they relate to it as well as they relate to a cell phone. So therefore to keep our kids in the classes, that is magic! . . .It keeps them in our classes.

Teacher D also noted this same phenomenon. When asked if she thought learners found any difference when she was teaching with the eBeam, she said:

> It's not the same. In fact the kids are more interested in using it (eBeam). The moment they see something new, they are more interested in using it. The moment you say the class will be held in the (other teacher's) classroom, they know we are going to be using the eBeam so they'll all rush in.

When describing her learners who could not read, Teacher A said she "found that those learners are really drawn to ICT. They love the computer and they like being involved".

One teacher noted that the eBeam could be seen as a "gimmick" to try and entice students to participate:

> I do see a benefit in it (eBeam). In that there seems to be another element of interactivity that is added...it really does encourage activity with the children. Ok, maybe it's a bit of a gimmick...but it does increase the interactive content of the lesson.

We see the need for a balance between using the eBeam, or any new technology for that matter, to draw learners into the class who would usually not participate, and the authentic use of an up-to-date technological tool. Some researchers warn that IWBs can be seen as a novelty and so initially attracted a lot of attention from learners, but this attention can wear off as learners became used to the technology (Levy, 2002; Merrett & Edwards, 2005; Glover et al., 2007). Other researchers, however, cite that learners' motivation improved while using an IWB over a long period (Weimer, 2001).The novelty might last for a while, but its pedagogic value must be uppermost.

A more nuanced understanding was expressed by Teacher B who referred to the technological affordances that ICTs provide, showing how their incorporation in teaching and learning environments can help learners become aware of the research and knowledge creation processes.

> Teacher B: And it (use of computers in teaching and learning environments) actually works really well because they are so much more in charge of getting the information and that's an important part of outcomes based curriculum that they must find the information. That they become aware of the producers of information and knowledge and they become aware of the how information is used and how they can use it and shape what they want to say.

So while the eBeam technology itself is novel and can capture the learners' interest – at least for a while – it is the use of technology to prompt epistemological enquiry that would seem, at least to one teacher, to have more enduring value.

3.5. Interactive affordances

The fifth most frequently mentioned issue related to the value of interactivity afforded by the eBeam. Armstrong, Barnes et al. suggest that "the IWB potentially affords interaction if the teacher perceives that it can be used in this way, and uses appropriate software that also affords interaction... This perspective suggests that there are no absolute properties of the IWB which enables us to predict the effects that it will have on teaching and learning" (2005, p. 459). The interactivity afforded by eBeam may be taken up or disregarded. Armstrong et al. (2005) point is clearly visible in this project, and numerous other research projects (Beauchamp, 2004; Moss et al., 2007). As an example, during her post-observation interview, Teacher D was asked if she used maps, pictures or other multimedia content when teaching her history class. Her reply was an astonished "no, I just wrote notes on it (the whiteboard)". Teacher D only saw the eBeam as a blackboard replacement, and as such her use of the technology was similar to her use of blackboards.

Teacher A on the other hand, viewed the eBeam as much more than a blackboard replacement, saying that it supported active and participatory co-operative learning.

> It's really the interactivity of the learning and teaching that can now take place. But obviously that would not be the sole resource in your class you need to take from all sides, you still need the text books and the Internet and all the other things we employ but in a sense I think it could open the world to many of the children. It allows for co-operative learning and I think that the children can then learn from each other and from that (the whiteboard). I think it would also help them to be more active and participatory in the lessons and that too would be beneficial.

Although most teachers felt that the interactive affordances of the eBeam were those that supported active participation in classes, Teacher B felt that they were benefits of the laptop and projector. He stated that although the eBeam did support interactivity between the learners and teachers, the eBeam itself brought along more problems than it solved.

> ...I feel that a projector, laptop and whiteboard would introduce a whole new way of interacting with material, interacting with your lesson and interacting with the learners. And I think that also brings a new interactive dimension to the way we are use to teaching. So that would be an important point to start from. Not because the eBeam is not interactive, it can work, but the problems that I had with it is that some part of me feels that it is not quite refined enough for the classroom teaching situation.

Similar to existing research (Smith et al., 2005), the most recognised benefit of the IWBs interactive affordances was the ability for teachers to stay in the front of the class, in a position learners recognise as a position of authority, whilst still interacting with the technology. Teacher A emphasized the fact that "you don't need to lose contact with the children when they're working. And you can access different programs on the board". She saw the eBeam as aiding the flow of her lesson, whilst still giving her access to resources that she would otherwise not have. Teacher C agreed with this, saying that she felt that using a laptop on its own drew her focus away from her class, even to the point of encouraging her to sit down while using it so she is at the correct level for the screen, while using the eBeam allowed her to interact with the class standing up. Teacher E endorsed this view stating that with respect to "class management, you have a full view of your class when using it (eBeam) as you're standing right in front of the whole class".

3.6. Cost

The sixth most frequently mentioned issue revolved around cost constraints. As mentioned above, all schools involved in this study are considered to be previously disadvantaged. A recent White paper on e-education showed that of the 6300 schools in the Eastern Cape, only 8.8% are equipped with computers, with only 4.5% of these using them for teaching and learning (Department of Education, 2003). The cost therefore of firstly equipping these schools with ICTs, and then providing ongoing training for the teachers would be considerable. Moreover, the additional cost of equipping schools with IWBs (both hardware and training) would add another burden onto the already large price tag. Throughout this study, we chose to use eBeam technology as it was the most cost-effective solution that was available in South Africa. The key question was clearly whether this cheaper and more versatile technology would be worthwhile for the Department of Education to invest in on a large scale.

It was interesting to note that throughout the user study, none of the teachers questioned the cost of the equipment, or the viability of a large-scale roll-out of IWBs in the Eastern Cape. However, the learners mentioned cost-related issues on a number of occasions. When asked if the ECDoE should install eBeams in all schools, some schools, some classes or not at all, learners from Teacher B's class answered saying "I think its good but can the government afford it?... if they have the money they should go for it (integrating eBeams into teaching and learning environments)". Teacher D's class raised related concerns about the safety of putting such equipment in disadvantaged schools:

> Learner: I would tell the government to put an eBeam in the lab only because the children in the school will vandalise them.
> Learners: Yes.
> Observer: Anyone else?
> Learner: Coz this environment is the location and there are thieves and they will steal it.

While the learners pointed out the possibilities of equipment being stolen or vandalised, Teacher C raised a related concern about the cost of maintaining the equipment. She was very aware of this particular drawback of using computers in the teaching and learning environment:

> The more we try to use computers for teaching and learning the more they break down and the less the number of computers and that discourages me from using them really intensively... The biggest frustration is when you take a class and you expect 10 computers to be working and suddenly 3 breakdown and you're only left with 7 working.

As well as budgeting for the cost of hardware and ongoing training, maintenance is an oft-neglected item that must be considered when rolling out ICTs in teaching and learning environments. Existing research in this field (Sharma, 2003) has also shown that inadequate funding is a large barrier that must be addressed if ICTs are to be successfully integrated into teaching and learning environments. We therefore conclude that the added benefit of interactivity must be weighed up against the benefits perceived by its users (teachers and learners). If a significant amount of additional money is spent on purchasing eBeams or similar IWB technology, the affordance offered by this technology must not only be discernible to researchers, but also to the everyday users of the system.

3.7. Participant preference – IWB vs. laptop/projector

Although the researchers had seen how the teachers and learners used the eBeam, data projector and the laptop and had discerned that many of the benefits attributed to the eBeam were essentially affordances of the data projector (e.g. the "big screen") or the laptop/computer (e.g. multimedia). The teachers (in the final interview) and the learners (in the focus group interview) were specially asked about their preference between using a laptop and data projector with or without the eBeam. Three of the five teachers and two of the five groups of learners opted for the laptop and data projector combination (Table 2). In Teacher A's class both the teacher and learners voted for a laptop/projector over the eBeam. This was an unexpected response, as we as observers felt that Teacher A was one of the most successful at integrating the eBeam into her teaching. She qualified this comment saying that she would recommend laptop/projectors to be used in most classrooms, with one or two eBeams that could be rotated around the school. Similar to their teacher, Teacher A's learners also preferred a laptop/projector to an eBeam, mentioning it on four occasions.

In Teacher B's case, the learners said they would recommend integrating both the eBeam and the laptop/projector into teaching and learning environments, saying that the two technologies "are a perfect team altogether". Teacher B himself was not as complimentary of the eBeam, saying that although the eBeam did make some difference to the class, it was the laptop/projector that made the biggest difference.

> ...But it (eBeam) would be useful for, I think more useful for other people who use other types of data types like maps or whatever. I think it would be very useful in terms of that and it is not 100% necessary but it was useful and I think that for the other learning areas it might be quite useful. But if I had to be honest about things then I would say that it was more the laptop and the projector that made the difference.

Teacher C made similar comments saying that although the eBeam did add an element of interactivity, it required much more planning, organization, and training to be used effectively in a classroom. She also mentioned the ease with which she integrated the data projector into her classroom:

> I planned to bring the eBeam into the lesson or classroom so it was not something that just happened on its own. But with the data projector it was different because I found it easier to just incorporate it into a lesson even if I hadn't initially thought I would.

She further suggested a gradual roll-out of technology where teachers are first given a laptop and a projector and shown how to teach with the new technologies. She then suggested that after a year or so, when teachers have proven that they could and wanted to incorporate the laptop into their teaching, they should be given an eBeam. In a quote that inspired the title of this article, she made sure to point out though that the real benefit of the two technologies was the data projector:

Table 2
Teacher and learner preference for laptop & data projector with or without the eBeam

School	Teacher preference	Learner preference
Teacher A	Projector	Projector
Teacher B	Projector	eBeam
Teacher C	Projector	Projector
Teacher D	eBeam	No comment
Teacher E	eBeam	Undecided

> Teacher C: . . .The real thing is the data projector, the eBeam comes with a data projector and that is the beauty. And the eBeam product I see as lipstick. Which does have its own place in a school.
> Observer: OK, so if you were to advice the Department of Education, what would you say? They must first look at putting data projectors in and then look for the lipstick later?
> Teacher C: Absolutely.

It was surprising to note that although Teacher D said she preferred the eBeam, she was the most incompetent at integrating the eBeam into her classroom of all teachers that we observed throughout the case study. During the focus group, we asked her learners how often their teacher used the eBeam and they responded saying that she only used it when we came to visit. In Teacher D's focus group, learners did not respond at all to the question regarding their preference between the laptop and data projector with or without the eBeam, and so their answer is denoted in the table by "no comment".

Finally, when Teacher E was asked his preference between a laptop and data projector with or without an eBeam he replied that he would prefer an eBeam. He qualified this statement by saying that like any other resources they could be underused so he would not roll them out to all schools, but only to schools that were passionate about using ICTs in classrooms.

> This (eBeam) is technology and it's a resource just like any other resource. You find schools who are given good text books and the school doesn't use them. This could be a resource that is given to a school and it just lies there and is not utilised. . .it should be taken to those schools that are keen and passionate about using it for learners to learn. In other schools it will simply vanish, and will not serve the purpose that it was bought for.

Teacher E's students were divided between the two options, with some saying they would prefer the laptop/projector and others saying they would prefer an IWB. When asked why they preferred the former technology, learners pointed to calibration issues and unfamiliarity with the technology on the part of the teacher.

Six months after the official feasibility study had ended we informally interviewed one teacher from each of the three schools (Teachers A, B, and E) to determine their current use of the eBeam. When asked which pieces of hardware (if any) she still used in her class, Teacher A answered saying "I use the laptop and projector mostly. We use the eBeam from time to time but not really... It just doesn't fit in as easily. The laptop and projector fits in well but the eBeam doesn't fit as easily". Likewise, Teacher B stated that from time to time he used the eBeam in his classroom, but that he was the only person in the school that showed an interest in it. He did mention, however, that other teachers now incorporated the laptop and projector into their teaching. And finally, despite all the calibration problems Teacher E experienced with his ill-fitted whiteboard, he stated that he still used the eBeam, laptop and projector.

4. Conclusion

This article has described the results of a feasibility study that was designed to investigate the use of eBeam interactive pen technology in three South African schools. In particular, this article has tried to determine the potential benefits and drawbacks of using the eBeam technology in their teaching and learning environments, before a large scale roll-out.

Teachers and learners were positively disposed towards what they termed the "big screen" and the visibility, visualisation and use of multimedia it affords even though they incorrectly attributed this feature to the eBeam, where technically it is the function of the data projector and laptop combination. Teachers in particular saw the use of up-to-date technology as a motivational factor for learners and commented positively on the interactivity that the eBeam affords, despite that fact than this feature was often disregarded. While only the benefit of interactivity was exclusively related to the eBeam itself, both drawbacks highlighted by the teachers and learners were related to the lack of technical skills in using the eBeam as well as its cost and safekeeping.

As most of the benefits mentioned by the teachers and learners seemed to accrue to the use of the laptop and data projector combination and most of the drawbacks emanated from the use of the interactive pen technology itself, we suggest that it may not be expeditious to attempt to "leap-frog" the use of technologies. Instead we suggest that an evolution of ICT related pedagogy is necessary to make optimal use of interactive

pen technologies such as the eBeam. This is particularly pertinent for developing countries such as South Africa where there is a dearth of ICT use in schools in comparison to developed countries such as the UK. Our study illustrates that because schools are moving from minimal or no ICT integration, in attempting to integrate interactive pen technologies such as the eBeam into classrooms, a valuable stage is skipped in this evolution. The result of this is that in most cases, the teachers' pedagogical strategies were not able to cope with such a jump.

Moreover, we are mindful of the potential drawbacks of "technology transplantation" (Tedre et al., 2006) and suggest that teachers need time to engage with the technology and to find ways that it can be used to suit their purposes as the technology needs to be subservient to their pedagogical strategies. This study illustrates the disruptive effects that technology can have when not fully understood or used optimally. We caution against imposing technologies on teachers and suggest instead that teachers be allowed to request the technologies they deem suitable to support their pedagogical evolution in the use of ICT in the classroom and offered concomitant training and on-going support. Our advice therefore to the ECDoE is not to roll-out interactive pen technologies, such as the eBeam, on a large scale as this would seem premature. Instead basic computer infrastructure, laptops and data projectors could be offered to, but not imposed upon the teachers.

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