

mLearning: the classroom in your pocket?

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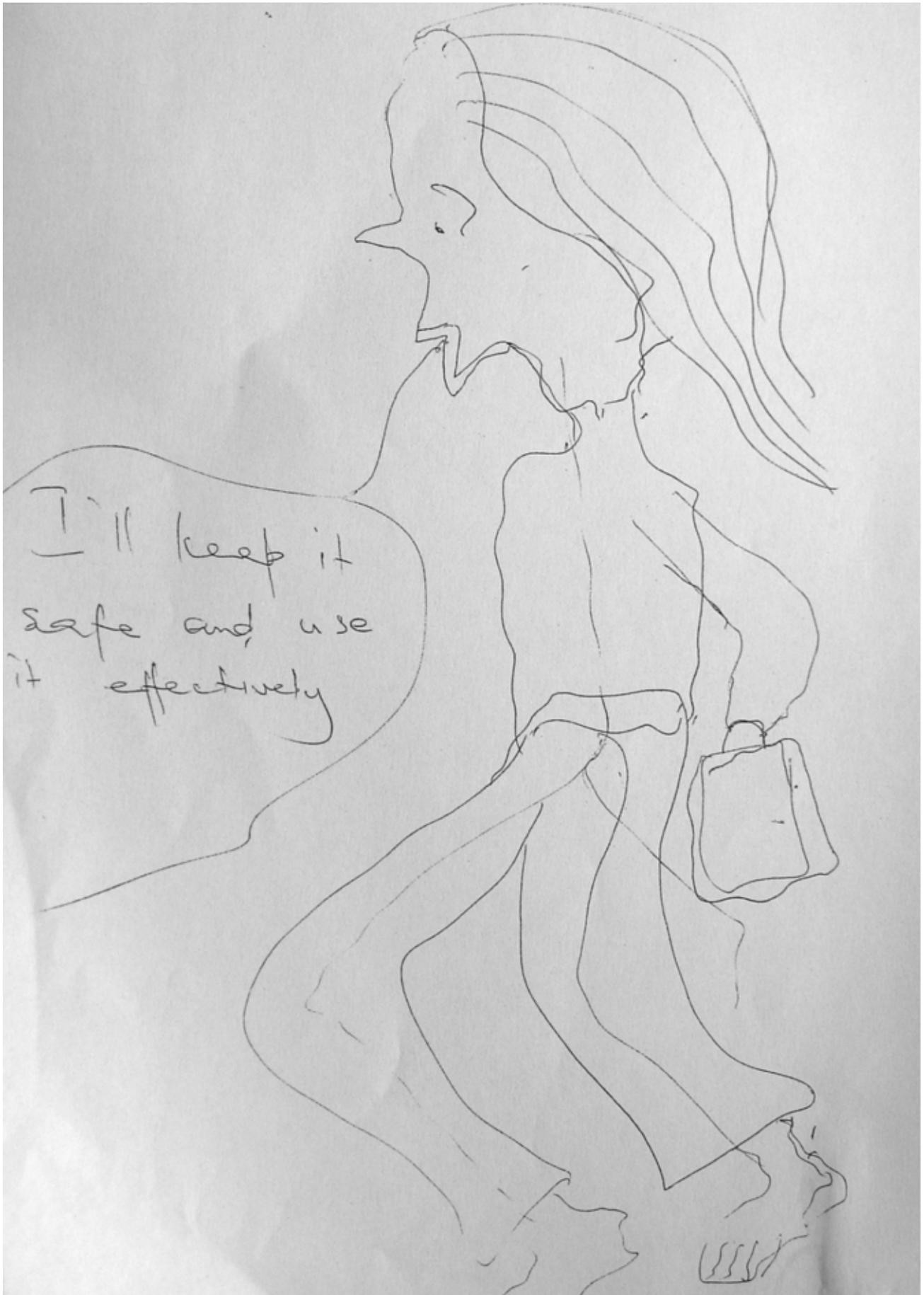
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'I'll keep it safe and use it effectively' (Teacher sketch, October 2005)

Abstract

Previous research (Leach et al 2006) carried out by into teachers use of laptop and handheld computers showed most participants rating both equally useful: those who expressed a preference for one device over the other identified the handheld computer as the best tool for teachers, particularly in rural communities (Leach 2006 - forthcoming).

This paper reports the findings of a subsequent 1 year project which focussed solely on the potential of handheld computers for teacher professional development. With the 'digital Swiss army knife' of a handheld computer, is it now possible to carry your classroom in your pocket?

Many studies have investigated the use of handheld computers in classroom settings but most focus on pupil learning (e.g. Fung et al.1998; Yarnell et al 2003). There is not yet a substantial body of literature on the potential of handhelds for teacher education, though Soloway (2002) argues that handhelds provide an opportunity for making major changes in educational settings.

This paper considers the fit between theory and practice, viewing the developing literature on mLearning (e.g. Naismith et al, 2004) as it might apply to teacher professional development, in the light of research evidence from project teachers using handheld computers. The teachers themselves used the analytical framework for teacher professional knowledge developed by Banks, Leach and Moon (1999) to consider their own experiences with the handheld computers.

This study finds that handheld digital tools hold a number of pedagogic and pragmatic advantages over laptop or desktop computers for teachers, especially in rural communities; however, further technical development is required to fully orient the devices to classroom rather than office practices.

Introduction

The Digital Education Enhancement Project (DEEP - www.open.ac.uk/deep) carried out an initial study into the potential of ICT for teacher education in developing nations, working with teachers and institutions in Egypt and South Africa.

The over-arching research questions for DEEP were:

1. How does ICT transform the pedagogic knowledge and practice of teachers and the communities in which they live and work?
2. What is the impact of ICT- enhanced strategies on pupil achievement and motivation?

Teachers used a variety of forms of ICT depending on their contexts, with a range of resources including ICT suites, laptops, internet cafes, digital cameras and digital video cameras, scanners, printers and a motorbike mounted digital cinema, both for their own personal and professional development, and for the teaching and learning of literacy and science.

In addition to the appropriate selection of digital tools mentioned, all project teachers were provided with a then 'state of the art', powerful 'pocket PC' [206 MHz processor] and small digital camera add-on and docking station, to facilitate their own professional study. The

mLearning: the classroom in your pocket (Power & Thomas, 2006)

DEEP professional development activities were installed on these devices in the form of illustrated e-books, together with a range of other resources (e.g. case studies, exemplar lesson plans, video clips of professional practice, illustrated poems, an audio file of Martin Luther King's 'I have a dream...' speech).

The findings of this work are published in the project report (ibid. <http://www.dfid.gov.uk/pubs/files/ict-teacher-education-no58.asp>) and elsewhere.

It was anticipated that the handhelds would serve two main purposes:

- 1) to provide sustained personal access to ICT, through which teachers might develop familiarity with relevant concepts (e.g. applications, documents, folders) and practices (e.g. cut and paste).
- 2) to provide access to the projects professional development materials (the ebooks and multi-media resources).

The research showed that teachers found the handheld devices particularly useful for professional planning and administration, as in this example:

Saraa reports that her capacity to plan lessons and schemes of work developed during the programme, she's begun to 'think how I could manage my classroom'. This account is borne out by observations of two lessons and by the range of products in her electronic portfolio, including a workbook planning how to teach place value in maths. Saraa suggests that the hand-held computer in particular has supported this aspect of her personal and professional development, because 'I am able to use it at home'. Prior to the project her only access to ICT was in the school's multimedia lab or at a friend's house. In the mid-project questionnaire (November 2002) she records that she has not really used the hand-held device. Towards the end of the second field interview (March 2003) it emerges she has begun to use it regularly.

'At first we didn't use it [the hand-held] to be honest with you. It saves time because at home I can prepare my lessons. I then download to the PC [at school]. This didn't happen before. This is better than using the pen! The whole process was easier than normal preparation. Preparing and planning lessons was routine, but now I came to be creative.'

More surprisingly, the teachers used the devices extensively and creatively in the classroom. Uses of the device were wide-ranging. Several teachers had 'frequently' made use of the voice recorder for curriculum purposes. Other uses included:

'Word for writing... I left the device to the students';

'I used the camera many times to take photos related to the lesson I'm teaching and also to write some information';

'listening to songs and watching song clips';

'making various slides on some animal and its various characteristics'

'We have used the jornada for sports days, for cultural days, for all the activities...in the classroom situation, we've taken pictures of our learners'

In end of project workshops, additional hand-held activities and uses of software to support field-work were introduced by curriculum specialists, such as environmental study, local history and community story telling, in response to teachers interest in developing their range of activities with the devices.

It was only as a result of teachers' exploratory use of the hand-held in field-work that the research team realised the extensive possibilities of the devices to support curriculum learning - the original research showed that teachers:

- used the handheld computers regularly, in and out of class
- used the handhelds 'anytime, anywhere' for professional learning
- said they would buy such devices with their own money, if they were affordable
- found the handheld equally useful as desktop or laptop computers; most of those who expressed a preference for one or the other said the handheld was the *better* tool for their professional practice.

Soloway (2002) had described handheld computers as 'the trojan mouse', as he sees in them the potential to make major changes to educational settings. However, most studies looking at hand-held computers as learning tools in classroom settings focus on pupil learning (e.g. Fung et al., 1998; Sestokas-Filho and Bonafini, 2002) rather than teacher professional development.

New models of learning emphasise social context, focusing the processes of professional learning and change within work settings - and for teachers, in the learning communities of classrooms, schools and other local groups (Moon et al, 2006). Local environment and human resource (e.g. local experts, local technologies) are seen as key. Peer support and motivation is given high value. Tools and technologies are seen as mediators of social learning, capable of both constraining and expanding work based practices (Chaiklin and Lave, 1993; Sharples et al, 2005).

Waycott and Kukulska-Hulme (2003) investigated the use of hand-helds to support adult learners studying on an Open University course. They reported that the 'anytime, anywhere' access to learning resources is an important advantage of the hand-held computer, enabling adult learners to fit study time around other activities.

Therefore we felt further study was required to focus particularly upon the use of handheld computers for teacher professional development, in the teaching of literacy and science at primary school level. All schools and participants are located in the Eastern Cape Province, and most serve disadvantaged rural communities. The research was facilitated by the provision of 25 iPaq H4150 'pocketPC' handheld computers funded by the charity Bridges (www.bridges.org). 28 teachers participated, with 60% being experienced 'DEEP' teachers, and 40% new teachers from their schools, or in some cases, from nearby schools.

Research Questions

Within the two over-arching DEEP research questions above, this study has sought to address three subsidiary questions:

mLearning: the classroom in your pocket (Power & Thomas, 2006)

- What specific advantages do handheld computers offer teacher professional development?
- In what ways do handheld computers complement other professional resources?
- What curriculum developments are enabled by such devices / what software development would enhance their use?

Methodology

Learning resources and tools

The main focus of the DEEP-ER research is use of handheld computers for professional, practice. To this end, core professional development activities were devised by the project team that could be facilitated - and implemented - primarily by handheld use. These activities are supported by professional resources relevant to the Eastern Cape context and created specifically for the project, including a brief study guide for home and school reference. In a radical departure from the previous DEEP study (which had used almost every available format and media to present the professional development materials, including print handbooks and activity cards, online web resources, CD-ROM resources and eBooks and multi-media both on the handheld and other computers), in this study the course materials were *only* provided electronically on the handheld, in order to test the viability of such an approach.

Most of these materials take the form of e-books/ e-resources intended for use on the iPAQs. Teachers were also encouraged to use the original DEEP resources (see <http://www.open.ac.uk/deep>) which were converted to run on the iPAQ H4150 . Content was deliberately developed with the local culture, environment, literature and community in mind (see exemplar resources Appendix A).

The handhelds came with the following software:

- Pocket Excel
- Pocket Word
- Pocket MSN
- Outlook
- Microsoft Reader
- Calculator
- iPAQ image zone

The project team had to instal the following applications:

- HP Foldable Keyboard driver software
- Adobe Reader
- Palm Reader
- Flash ActiveX plugin for Pocket Internet Explorer

and resources:

- DEEP-ER Science and Literacy Professional Activities & related resources

- Poetry
- Xhosa Bible

In addition to the handheld computers, the project team also purchased a number of iPAQ keyboards, SD Memory Cards and pocket digital cameras to enrich use of the iPAQ H4150, so that images could be shared between camera and handheld, and that longer writing might take place.

Equipment distribution was determined by the participants and is shown below.

Participants	Equipment
<i>All schools</i>	1 iPAQ with memory card 1 iPAQ keyboard 1 Camera Any previous DEEP equipment: laptop; jornada; printer / scanner as remained available
<i>Lead schools*</i>	additional iPaqs with memory card (1 per teacher, to a maximum of 3 iPAQs per school)
<i>Clusters</i>	1 additional camera and keyboard for use by schools in the cluster
<i>Project co-ordinator in South Africa</i>	1 set of all new equipment for project advocacy / leadership / support

*a lead school being one where ‘DEEP’ teachers had demonstrated skill in using ICT in their teaching, and expressed a desire to develop as ‘teacher leaders’ or ‘teacher researchers’, offering support and guidance to their peers.

Research Instruments

To develop a representative picture of the experiences of project participants, the research used both survey and participatory research methods to gather data.

A number of survey research instruments were deployed through the project:

- entry surveys and individual concept maps
- mid-way evaluations and recording of project artefacts
- exit surveys and recording of project artefacts

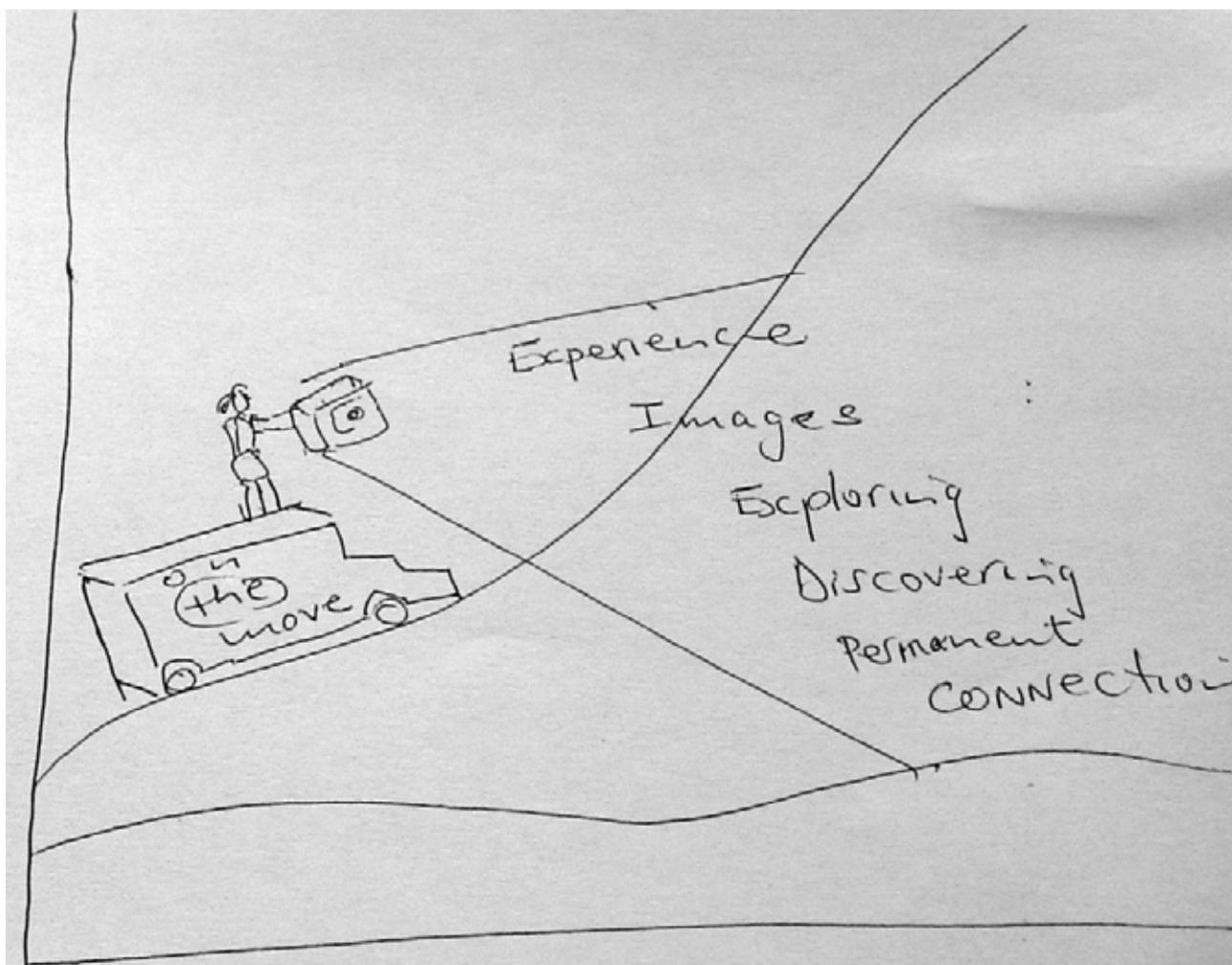
In addition, participants themselves used the model of teacher professional knowledge developed by Banks, Leach and Moon (see Banks et al 2005, and summarised by Leach in Appendix B) as an analytical framework for their own reflections and discussions. Teachers met regularly in clusters to support each other, and recorded their reflections in research diaries. At the interim workshop, teachers sketch-drawings of their experiences were used to help the group identify common threads of experience for discussion. At the final evaluation workshop, teachers in groups produced 5 minute ‘mini-documentary’ videos of their experiences.

Time Line

- October 2004 - March 2005 - Resource development & project planning
- March 2005 - Launch workshop (2 days)
- March - October 2005 - School based activities
- October 2005 - Interim Workshop (1 day)
- October 2005 - July 2006 - School based activities
- July 2006 - Evaluation Workshop

Findings - early analysis of the data

Survey data showed that teachers were using the handhelds both at school and at home, and often travelling between the two - the handheld digital tools did offer 'anytime, anyplace' professional learning opportunities, and teachers were keen to take advantage



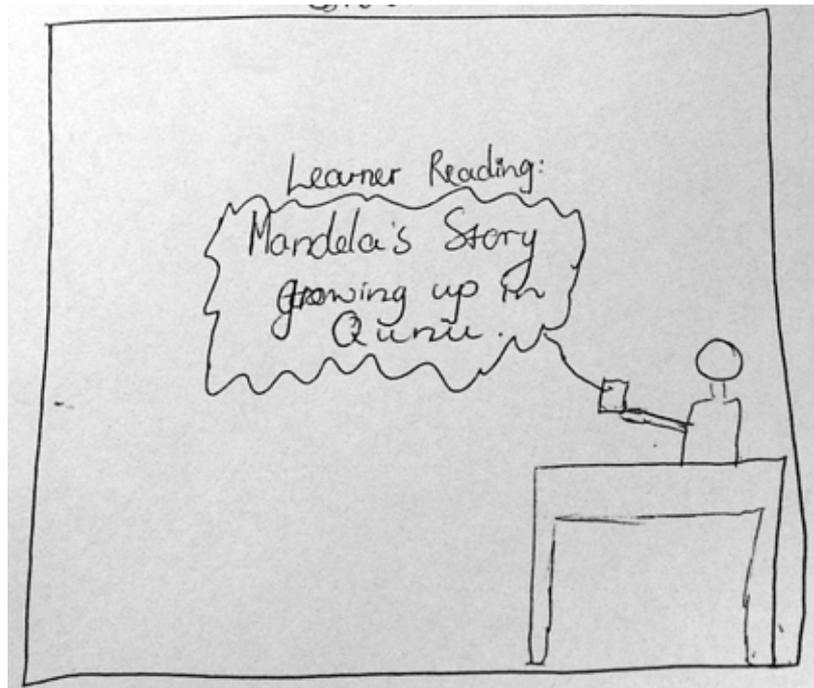
of this.

Teachers sketch - my experiences with the handheld computer, October 2005

For personal and professional development, over half the teachers had used the literacy eBook and resources, and over half had used the science eBook and resources. Almost 80% of the teachers reported the project materials as very useful learning resources.

Several teachers had also used specific items or parts of their professional development resources as a classroom resource for learners.

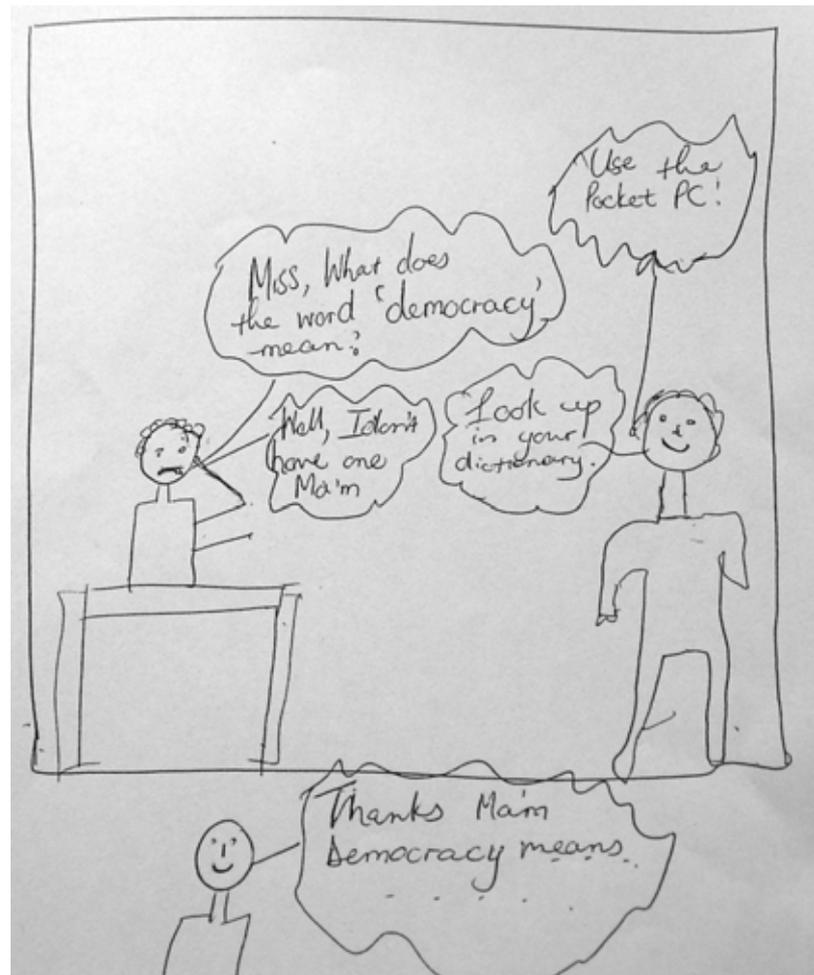
Indeed, most affordances of the PDA had been pressed into service as a classroom resource or tool at some point. It seems to be the fact that the PDA can 'become' many different classroom resources that makes it so appealing to the teachers. One pocket sized device can be at one moment a planner, at another a mark-book, the next a dictionary, a calculator, a book to read, a tape recorder for recording second language work, a computer for word processing and spreadsheets, a photo album of class experiences and the world outside, a music player, and on and on. 1 in 5 of the teachers had even used it as a Bible for religious instruction during the school day.



'Learner Reading: "Mandela's Story - Growing up in Qunu"'
(part of a project eBook)

In the classroom:

- over 90% of the teachers had used the camera both to take photos and share them with others (pupils and peers) as part of their professional practice.
- 85% used the handheld as a calculator
- 65% of teachers regularly used the dictionary as a tool for learners, and for themselves at home
- 65% used the handheld as a word processor
- 58% used the handheld as a voice recorder
- 43% had used the handheld as data collection tool, using spreadsheets



'Miss, what does the word 'democracy' mean? Look it up in your dictionary. Well, I don't have one ma'm. Use the pocket PC. Thanks Ma'm. Democracy means...[Teacher Sketch]

Teachers own reflections showed that for many, there was an initial period of feeling 'lost' with the handheld. It took most of the six months from launch to the interim workshop just for them to feel that they were starting to be comfortable and familiar with the tool, even though it was 'their own' mini-computer, and they had permanent access to it 'anytime, anywhere'.

This is salutary given the many programmes that expect teachers to use new ICTs (computer suites) with pupils, despite the teachers having very little by way of sustained access to the tools before-hand. It also reflects the finding of Apple Computers' long-running ACOT project (<http://www.apple.com/education/k12/leadership/acot/>), that it takes a long time (up to 3 years) for teachers to fully and comfortably embed new technologies into their practice, and Solloways' (ibid.) observation that such time is reduced to a half or a third with handheld computers, because of the sustained access and interaction.

A second theme to emerge from the teachers own reflections was a sense of 'seeing possibilities opening up', of excitement and potential.

50% of teachers commented upon how they had begun to used the handheld for planning and administration.

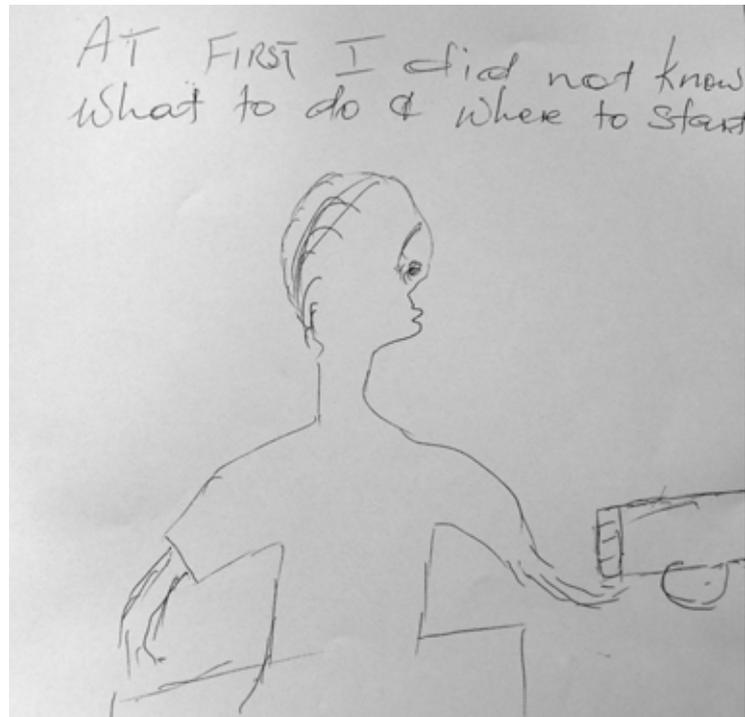
'It helped me to plan my lessons, based on what is on the PDA [the eBooks and other course resources]'

'I use it to write some reports for our cluster'

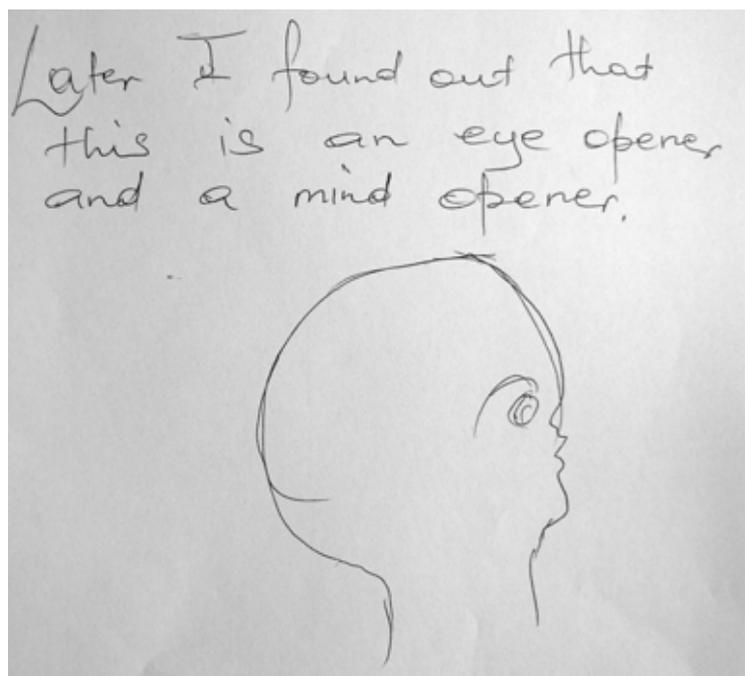
'It reminds me of the work I must do and the date of something I'm going to attend'

'Even my Curriculum Vitae is with the PDA, so for always move around with all that can be important...'

'It stores information and reminds me easily and makes my work easy. That's what I like - it's handy. I can go anywhere with my information on the PDA'



'at first I did not know what to do, or where to start'



'I found out that this is an eye opener and a mind opener' (Teachers Sketch)

Finally, reconfirming the original findings, 85% of the teachers said they would be willing to spend their own money to purchase a handheld computer to support their work; over two thirds of the teachers in the study found the handheld computer as or more valuable to their practice than the laptop computers or desktop computers.

Technical Issues

Research and Development in creating electronic resources for the 25 HP iPAQ H4150
As in previous project work, in order to extend the provision of content to the teachers in the project, add-ons and extensions to the on-board software were installed.

Web pages and multimedia elements

A Flash plugin was required to support the more interactive resources made available in the project and visual examples of literacy work. The iPAQs already had Pocket Media player available, so the web pages needed to link locally to audiovisual files showing teacher practice. Embedding these video clips in the customized web pages was the desired approach; however changes in the Pocket PC operating system no longer supported this.

Capacity and batch processing

In order to provide the devices with a larger memory capacity- and to attempt to centralise resource provision, the project team decided to provide project content on SD Memory Cards, which might also be used as transferable personal storage for use with shared digital cameras and DEEP-ER research outputs. Installation of programs, however, continued to require synchronization with a PC and batch processing the number of applications required.

Volatile memory and battery charging

Battery maintenance issues identified in previous research were seen to have improved on the iPAQs, but still not ideal. Both main and backup batteries are rechargeable, however on-board memory continued to require battery backup to maintain data.

Teacher resource provision via eBook

Investigations into the choice of eBook platform included use of Microsoft Reader, Adobe Reader and Palm Reader [now called eReader], with summarized findings below:

Microsoft Reader – default, stable and packaged application (not deleted on battery loss/hard reset), problematic creation process, limited embedding. Annotations possible

Adobe Reader – reasonably faithful reproduction of PDF files, allowing for comments to be read. No annotation provision. Application occasionally prone to crashing, requiring soft reset. Program (or shortcut to program) lost on battery failure.

Palm Reader – good creation and rendering of embedded objects; annotation and highlighting provided. Application prone to faulty menu generation, requiring soft reset to remedy. Program (or shortcut to program) lost on battery failure.

As a result, resources were initially provided in all 3 formats, playing to individual application strengths. Enabling annotations of the content by the teachers was seen as a crucial element in allowing personalization and appropriation of the content and resources for professional use. Legacy content remained in Microsoft Reader format, while largely image-based resources were provided in Adobe Reader format and resources requiring a large degree of interaction were provided in Palm Reader format, due to its more user-friendly creator interface. This, in time, was hoped to allow teachers and learners to create and share their own electronic resources.

Teacher feedback

Once users were operating the devices themselves, another major issue quickly emerged i.e. the instability of reader software requiring frequent soft-resets. Teachers welcomed the ability to charge the iPAQ while docked in the keyboard (not available on the Jornada), though only having a mains socket charger proved a drawback.

Some of the experienced handheld users consider the iPAQ less robust than the Jornada they were previously using because of the latter's screen cover.

After time, other substantive feedback was the loss of the additional programs on eventual battery failure – so although the resources were still present on the card, the means of accessing these evaporated. Despite improved technology, on-board batteries drained quickly even if the handheld was not in use.

Technical Recommendations for educator use in rural locations

A convergent device with true movie capture (incl. sound capabilities) is required, to allow direct capture of the environment and subsequent sharing with peers (and other devices). The device should be able to sustain data without power, but also be able to recharge from USB power sources as well as mains. Ideally connectivity to the internet should be on-board, however simple, reliable connections via Bluetooth to mobile phones, or WiFi to school wireless networks should be investigated. Additionally:

- Provision of on-board Flash-RAM should be standard, with a secured area if required, rather than RAM/ROM hybrid allowing user data loss
- A combined power saving and backup option should be introduced to save the current state of the device for planned, prolonged periods of inactivity
- Keyboard driver software should be provided as standard, so as not to be lost on battery failure/hard reset
- Syncing interface (PCB edge connector) should be more robust – both data transfer and battery charging could be lost at same time
- Alternative syncing methods could be provided– Bluetooth/WiFi

Summary

The handheld computers do support 'anytime / anywhere' learning, but to be fully effective as a sole means of accessing courseware, it would be essential to have an entirely non-volatile architecture: all of the teachers lost access to the course materials due to memory failure at some point.

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The light-weight, long-battery life, highly portable nature of the devices is highly valued by teachers in or travelling long journeys to schools in remote rural communities.

Almost all teachers in the study used the handhelds for both personal professional development, and for classroom practice with learners. The range of affordances of the handheld computer, the way it can 'be many things' and serve many purposes was highly valued by project teachers.

Since this project began, high-speed wireless data connections have become increasingly prevalent and cheap to access, even in the rural areas of South Africa. Adding the ability to access the internet and email would substantially enhance and transform the educational possibilities of such handheld devices, and indeed many smartphones are now becoming available that combine all the abilities of the handheld computers and cameras used in this study with such wireless network access in one device.

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