Researching mobile learning - Interim report to Becta Period: April - December 2007

Angela McFarlane

Pat Triggs

Wan Yee

University of Bristol

January 2008

Contents

Executive summary

Background

This is the second interim report of a Development and Research (D&R) project focused on the impact of 1:1 personal ownership of mobile devices. It presents findings from the second phase of a two-year research project and builds on the first interim report (July 2007) which covered the period September 2006 to May 2007. This report will be of interest to those engaged in the provision of ICT for learning, particularly policy makers at all levels and school leaders.

The research is located within two ambitious initiatives, Learning2Go in Wolverhampton and Hand-e-learning in Bristol. These projects have enabled every pupil in a year group and their teachers to have a mobile device. In both cases the initiatives were the vision of the local education support service: the local authority in Wolverhampton and a city learning centre (CLC3) in Bristol. These teams of professionals have been essential to the projects, providing leadership, staff development, advice and technical support.

Three primary schools and two secondary schools are involved in the research. In all cases the head teachers have shown significant commitment to the vision of embedded use of ICT in the school through the use of personal mobile devices. In the school year 2006-07 the pupils with devices were in Year 5 and Year 10. The research project continues until September 2008, thus following these learners through a two-year period, ending with a major external assessment point, Key Stage 2 SATs and GCSEs.

In all cases reported here the devices are being funded by parental contributions linked to grants from the e-learning foundation. This means that parents make a monthly payment over a two-year funding period, and the schools administer the collection of these funds. The learners thus have full-time ownership of the devices, including weekends and holidays. ‘Mobile devices’ in the context of this research are portable, mobile technologies which can be held in the hand and used in any location or context. A range of devices can be included within this definition. In this project the device that was initially provided to teachers and pupils was a PDA (Personal Digital Assistant) or a customised PDA known as an EDA (Educational Digital Assistant). In all cases, each device was equipped with a mobile version of an operating system found on PCs, wi-fi capability, the ability to read SD memory cards and an integral camera. The lead agencies in each location selected additional applications and content to be installed or made available to the particular user group via an SD memory card. The battery life of each device was a working day. Devices are wireless enabled and all schools involved have wireless access.

Key changes since the last report

A number of factors have had an impact on the progress of the implementation project which in turn has impacted on the research. There have been some changes to both primary and secondary sample groups, delays in the supply of devices and some change in focus in the secondary phase. The data set for the primary phase is broader and more representative than that used in the first interim report (July 2007).

One primary school has been part of the research since autumn 2006, and was largely the subject of the July 2007 report. For a number of unavoidable reasons, in two of the primary schools recruited to the project, we were able to begin collecting data only at the end of the spring term 2007. In one of these schools the devices arrived in the school in the spring and were new to the children and their teachers. The second primary school was recruited to the project in the spring term (to replace a school that had to pull out of the research) but the children had been using mobile devices from the beginning of the year. In all three schools the research is continuing with children in Year 6 who had devices in Year 5.

All three primary schools we are working with are e-mature. Both Wolverhampton schools had been previously involved in L2G and the Bristol school has two years prior experience of mobile devices in mixed Year 4/5 and Year 5/6 classes. In the three schools in this reporting period there was a mix of teachers who were experienced and novice users of mobile devices in teaching and learning.

In the secondary schools in Bristol the experiences of the first year of the project led to a major re-think and re-launch in the autumn of 2007. Both schools remained committed but a ‘fresh start’ was judged to be strategically necessary.

The issues around implementation identified in the first year were taken very seriously by the CLC as Project Leaders and the schools as participants. Together they reflected on their experiences and the research evidence. Three issues were identified as key contributors to problems encountered and a less positive take-up than had been hoped for:

- Lack of infrastructure in the schools – wireless capacity in particular
- Rushed initial training for teachers
- The choice of science as the subject through which to promote device use (which coincided with a major change in the science curriculum for GCSE).

As we reported in 2007, take-up by secondary teachers was varied. In science the majority of teachers were too preoccupied with the new curriculum to take on another challenge. The idea that the provision of a new tool which would offer access to content relevant to the new curriculum would act as an incentive to take-up of the devices proved to be mistaken. There was also some indication from the

teachers that there was a mismatch between what had been promised and what materialized, especially in terms of content. High levels of device breakage also emerged, although this was linked to non-use as devices were not valued.

In the summer term 2007, these and other issues, for example teachers feeling little sense of ownership of the project, were identified and addressed. Positive aspects emerging from the initial phases of the project were identified and built on.

Prior to the re-launch:

- improved wireless access was installed in the one school where it was required
- teachers who showed enthusiasm in incorporating mobile devices into teaching Year 10 students were identified and encouraged to continue with individual support
- it was noted that in one school some teachers of English were already using mobile devices in productive ways and so this subject was selected for focus in the re-launch
- the model of CPD was revised

The project re-launch featured a new style of device. The decision to change was largely determined by the fact that the device selected for the first launch was no longer in production. Before the re-launch in year 2, the CLC held an Open Day where schools could see a range of devices. All had an in-built camera and wi-fi. The reaction to the one eventually chosen was universally good; in the view of teachers, it 'doesn't look like a mobile phone'. – although it is one. The main differences between the new and 'old' devices were a higher specification system which meant that data was not lost if the batteries lost power, increased storage, 3G connectivity, the size and design, larger screen size and in-built keyboard (it is a mini-clamshell style device). The CLC entered into a contract with a major service provider for data services. As the level of breakage was not easy to predict the CLC also made certain that they have a good insurance scheme in place.

The Year 11 students in both schools continue to use the devices they acquired at the start of the project in 2006.

In September 2007 the project was re-launched in one school in Year 10 and with a focus on the English Department. In preparation for the re-launch the level of consultation between the English teachers and the CLC increased and began earlier. An Adviser from the National English Strategy was involved as a consultant, along with advisory teachers from the LA. All took part in a two day CPD activity. The potential of mobile devices for English subject teaching and learning was reviewed. The enthusiasm of the Strategy Adviser and his endorsement of this potential were important in creating positive attitudes.

In the second school the new model of device is being used in the Year 7 Learning to Learn programme. Tutor Group time is allocated for acquisition of skills and discussion of appropriate use. Year 7 was chosen because the ethos of learning to learn and pupil empowerment resonates with the original project objectives of increasing learner autonomy. With the school's increasing confidence in the potential of mobile devices it was felt that starting with the new intake of students was logical. In addition, awareness of increasing interest in mobile devices in primary schools meant that issues around transition could begin to be considered.

Year 11 students continue with their devices and in January 2008 the Deputy Head in one school will lead the reintegration of mobile devices in the Y11 GCSE Science revision classes planned for the spring term.

The project and the research are ongoing in both secondary schools and with both devices. Thus data continues to be collected in both schools from Year 11, in one school from teachers and students in Year 10; and in the other from students and teachers in Year 7. These 'new' year groups are thus the core (though not the exclusive) focus of the re-launched project.

The research

The design of the research project is developmental, in that data collected is progressively analysed and findings are fed back regularly to teachers and head teachers for their validation and comment. The researchers' role, initially, was to record and provide a mirror. As the project has progressed, teachers, as co-researchers, are being invited to make a contribution to the analysis of data and the creation of knowledge. The research has fed into developments in implementation and practice. At regular reporting points, the findings are collated, shared with all involved and disseminated more widely through reports such as this one.

Data on attainment, attendance and learner disposition were collected at the start of the project. These provide a baseline for comparison with parallel data sets to be collected at the end. This data does not therefore feature in this interim report.

In the first two terms of the research data sources included interviews with heads, teachers and learners; a pupil survey on personal experience of technology; day-long observations of groups of pupils supplemented by informal interviews; and periodic week long pupil diaries. These data informed the first interim report (July 2007). In the next two terms classroom observations and interviews with teachers and learners were repeated. Video of screens was captured as learners used and talked about their devices. Also in this period, when trust had been established between teachers and researchers, video recordings of learning and teaching episodes were collected. Data collected in this phase (April – December 2007) provide a basis for this second interim report.

The research questions addressed by the project are:

- What pedagogic models best support effective use of 1:1 access via a mobile learning device to educational resources and tools?
- What impact on attainment and other defined learning outcomes can be linked to this intervention?
- What are the implications of mobile technologies for practitioners, particularly in terms of CPD, barriers to engagement and embedding in pedagogy?
- Has there been a quantifiable impact on teachers' productive use of time as a result of this intervention?
- How have the relationships with homes and communities been developed through these interventions?
- What are the technical challenges for this kind of access and use, and how have they been met?

Findings of the research

Overall

The pioneering use of technology in these projects has required a significant investment of time, energy, imagination and expertise in addressing economic, technical, social and pedagogical challenges. The challenges encountered have taken time to address. The leadership and support the projects have provided has been central to the development and integration of the devices in teaching and learning, in and out of school. The degree of risk-taking shown by the project leaders and teachers should not be underestimated.

In both primary and secondary phases we are seeing evidence of the value of incorporating mobile devices in teaching and learning. What the projects have discovered, and are still discovering, can usefully inform other 1:1 initiatives.

In the primary schools there are clear indications that the use of handhelds is bedding down in very positive ways. Most marked is the confident and independent use of devices by many children. In one school where the Deputy Head/ICT co-ordinator/Year 5/6 teacher has been seconded elsewhere the teacher, who last year was an NQT and using handhelds in Year 4/5 for the first time, has taken over. The project has survived the removal of a ‘champion’ mainly because the use of handhelds is securely embedded in the school and has the total support of the Head Teacher. The children remain confident and committed users.

The introduction of 1:1 mobile devices has been more problematic and complex in secondary schools than in primary. (See Section 1.1) Since the re-launch there are encouraging signs of success. In both schools, the acquisition of a different model of

device has made a substantial impact. Teachers who have experience of using both models have welcomed the new design. They describe the impact on teaching and learning in terms of making pupils' work easy to project, teachers are able instantly to see what pupils have done, feedback is speedier and student gratification from doing this type of work is much more instant.

Other factors affecting this success include: increased sense of ownership of the initiative in both schools. In one school the extensive discussion with the English department undertaken in advance of adoption about the role of the device in the subject, provision of some examples of positive uses and curriculum support from the CLC have been effective. The English support coordinator has worked closely with the Head of the English Faculty in developing resources for immediate use by the teachers. In English classes there are developments in assessment using the devices and there is increasing evidence of the mobile devices providing opportunities for independent learning. There is evidence also that boys, in particular, are responding well, and are producing more detailed writing.

In general, in both phases, devices are being integrated in meaningful ways, and experienced teachers are innovating and experimenting with using the device to suit the subject and their learners.

The relationships between schools and the projects are changing and developing. Schools and teachers in both primary and secondary phases are increasingly exhibiting a desire to take ownership of mobile device project development. A shift within the project teams from the specification and delivery of access to devices to a role where they are enabling school-based initiatives is evident and being productively managed. For example schools are being supported in defining their own software 'image' for configuring the device. This may not differ much, if at all, from the one recommended/supplied by the project but the shift in responsibility for its specification is significant.

There is also evidence of a 'viral' effect among teachers who do not have devices. This is especially evident in the secondary schools where some teachers who are not directly involved in the project and so do not have devices are making use of the devices the students have with them in class. For example this is happening in Year 7 subject areas such as History, English, Modern Foreign Languages and Geography.

As teachers in both phases come to understand more fully the potential of mobile devices and see examples of use in authentic teaching and learning contexts (especially involving their colleagues) they are increasingly likely to express an interest in incorporating them in their own practice.

The enthusiasm of learners in both phases is having a perceptible effect, particularly as they suggest to teachers ways in which their devices could be used in class. In the secondary schools, where learner enthusiasm has been more marked after the re-launch, there is evidence of pupils wishing to use their devices in all their subjects. In some cases this is contributing to the 'viral' effect described above and arousing interest in the devices among some teachers not directly involved in the project. In general non-project secondary teachers do not discourage autonomous use by students. However, many secondary students are dismissive of most non-project teachers' understanding and command of the device and its possibilities.

Overall, as both projects develop, positive indications for sustainability within the schools are becoming more evident.

About teaching and learning

A range of findings related to teaching and learning have been identified by the research. These are grouped here under appropriate headings.

Attainment

We have as yet no hard measurable evidence of a possible impact on attainment of mobile device use since our sample students will not have end-of-key stage formal assessment until summer 2008. However, we are gaining indications from teachers who have looked at end of Year 5 outcomes and Year 6 SATs results (for mobile device users not included in the research sample) which suggest a positive effect of device use on attainment. This research will follow up these indications when we have attainment data at the end of the school year 2007-08.

At this point we can report. The introduction of 1:1 mobile devices has been more problematic and complex in secondary schools than in primary. (See Section 1.1) Since the re-launch there are encouraging signs of success. The size of the devices makes it possible for them to be taken from a pocket or bag and accessed very easily in class, in a car or bus on the way to and from school, even to be taken comfortably to bed. Large amounts of material (provided or learner-created) can be stored in one place on a device. Combined with these points, the instant-on facility means that access to stored material or the internet is immediate. The intimacy of the device in the hand seems to be attractive, especially to learners in the primary phase, and the size of the screen appears less daunting to some writers. Observations of primary phase learners record children writing curled up in chair or on cushions, walking around the class, standing in line waiting: all situations which would not support traditional writing tools or larger/heavier technological tools.

Students comment on the value of having instant access in class to revision material on the internet:

"The one thing that has got me through my exams is Bitesize. So if there's anything in lessons that you don't understand or the teacher is busy with other things, instead of just sitting there, you can check -- its got all the possible subjects for GCSE eg in RE its got all the subjects in religious studies….so Buddhism, Christianity, if you go to revise, its fairly quick the internet on this [the mobile device]."

Jake (Year 11)

In the primary phase, drill and practice software in mathematics has proved extremely popular with teachers and pupils. Learners are happy to spend time on such activities, in and out of school; and think of this as 'play' or 'a game'. Learners also enjoy recording their progress through the 'games'. Mobile device ownership has made it possible for access to such software but observations of children playing these games while walking around, in the playground and the classroom, and of them showing each other their screens as they do this, suggests that again that it is way the device fits in the hand that encourages use. Teachers have attributed increased attainment in mathematics to this kind of activity since it increases the time spent practising maths.

Increased attainment in writing has also been remarked on by teachers for some individuals. There is some evidence of increased amounts of extended writing done (in particular by boys) using the device.

Boys have something to write about and have the tool which enables them to sit comfortably, talk, share and count the words.

"At camp we had to write things so people like mum and dad can know what we was doing. We had to go up to our rooms and write it. I liked it 'cos you had time to sit with your friends. In the room…like tell them what you did and then like sit down and write while you're telling. (names three friends) we all wrote together. We usually wrote a lot.

(He shows me some of the files) That's 108 words… That's 560 words… (Do you always count the words?) Yes!"

Finlay (Year 5 , who says he dislikes writing on paper)

Writing initiated by a girl at home merges with a required activity at school. She uses the mobile device for planning rather than drafting which she does traditionally with pen and paper – an illustration of the personalised orchestration

of tools by the writer.

"I did a story plan at home. The characters in the story are Mel and Dean and they um work as scientists in the laboratory and they have an accident in the lab and they find out that they've made a clone. And the clone is just a small child so they can like pass them off as their kid, their child and they like live happily for the rest of their lives… I started writing it at home…on a piece of paper. (Not on your mobile device?) No cause I was reading from my [mobile device] for the plan…And then funnily enough we was doing a science fiction one in Big Writing so I got to do this… It was a bit different when I wrote it at home but then I changed it for what we was doing for Big Writing."

Daisy (Year 5)

Teacher perceptions and emerging indications of the apparently positive impact of mobile device use on attainment will be followed up and investigated in the next phase of the research. A number of interesting questions arise as a result of this use of the devices, not least whether this enthusiasm and productivity will carry over to paper-based work, and be captured in formal assessment.

Autonomy and personalisation

Evidence is building around the value of mobile devices in the personalised learning agenda.

Learners in both phases are demonstrating clearly their confident and independent use of devices.

Another illustration of the way learners respond to the small size and easy portability of the mobile devices in these projects. The use of different available functions, the taken-for-granted interactions between handheld devices and computers, and between home and school, are clear in this vignette.

"I do write essays on my [device] using the portable keyboard and that's really useful so if it's a revision lesson and I'll take notes on the [device] and then I can refer to the internet at the same time. And at home I use it as well for writing up things in neat - on the [device] and on the computer. If I need to do it on my [device] so I can take it somewhere, if I need to write up a small essay I take in into school and print it out there…… In my normal music lessons I use it to take pictures and videos of different microphones and how to set them up and things like that so that I can refer to them at home."

Richard (Year 11)

The handheld mobile device plays its part in facilitating the effective completion of a coursework assignment. Again it fits easily and unobtrusively into class-based lessons.

"I used it on [word processing software] 'cos it's useful for spell check and the teacher can check it and you can put it on the shared files and he can check what you've done and send it back to you so its really… I also went home, put it on my computer, checked it on there, did a bit and put it back on my [device] and checked it in a lesson when I'm not busy…

I went on the home computer for research and did a little bit on the [scanned in material] which is in the Student share and that was useful.."

Joel (Year 10)

Autonomous use by pupils in and out of school is increasing. The reasons for this appear to be varied. In the secondary schools the willingness of non-project teachers to agree to and even encourage learners' use of their devices has had an effect. In primary schools technical issues around wireless access have affected the ways the devices could be used. Teachers have worked confidently within the constraints and one result has been that teacher-directed activity has been less prevalent but very thoughtfully planned. With less teacher-direction for the use of the device we have seen many more children using their devices autonomously in personalised ways to take notes, plan and review their writing, plan sequences or investigations (concept mapping), organise their device and their work. They have frequently asked if they could use their devices or suggested how use of the device might help or improve activity. Teachers have invariably given them the choice to use or not use their devices.

Choice of this kind means that some children have been making much more use of their devices than others. Although different patterns of use could be seen as an aspect of personalisation, we are interested to understand them more fully. The research is finding that learners are spread along a continuum from very high to very low users, and this relates to in and out of school use. The reasons for and consequences of this, with a consideration of the pluses and minuses of increased pupil autonomy, are part of our ongoing investigation.

With increased autonomous use in and out of school, in formal and informal activities, there is evidence of a need to specifically address with students some aspects of e-learning: a critical approach to the potential of mobile devices in learning/learning to learn; safe and appropriate use; developing critical thinking and skill in accessing and evaluating information sources. This analysis is based on

observed use of mobile devices during lessons. The appropriateness and efficacy of device use is mixed.

A determination to use the device when the task is poorly understood is likely to be counter-productive.

Two Year 10 boys in a science class are determined to use their devices. The task is to sketch a graph, and should take a minute or two on paper, or a drawing package. However, these pupils associate 'graph' with 'spreadsheet' and waste some 20 minutes trying to sketch a graph in a spreadsheet, which is impossible. This shows a failure to understand both the practice of sketching a graph, and the functions of a spreadsheet. Because they have their device they use it. Because the teacher assumes they are competent with the device she assumes they are competent with the task and does not examine what they are doing. The result is a waste of time and a wasted opportunity to identify a fundamental misconception and address it.

The failures in basic ICT competences revealed through increased access are unrelated to mobility. However, the increased access afforded by personal ownership of mobile devices (for example whole class access to the internet, instantly at any time) does mean that there are more opportunities to teach skills and improve competence.

Related to pupil autonomy, in primary classes we are also seeing the spontaneous development of networks of social and learning practices around the use of handhelds eg in swapping files, sharing music, sharing expertise with the device. These operate in and out of school. Less frequent or less confident users involved in these networks can and do draw on the skill and experience of the more 'expert' users. These networks have the potential to create (and in some cases already are creating) communities of practice around not only technology use but also around learning. Children in different social groupings that do not include enthusiasts do not have access to this.

In the secondary context similar networks are evident and some students are identified as technical trouble-shooters. These are not always the officially appointed 'student technicians'. Facility with a device can give status and be seen as 'cool'. We are also finding in both phases that an understanding of the potential of the tool, learned from using it informally for music or entertainment media, leads to a realisation of the possibilities for school learning. Alongside this there is frustration at the teachers' apparent inability also to see this potential.

Running commentary as a student demonstrates using his mobile device. The emphasis is on personal use, including an aside on how the device enables him

to circumvent the school's prohibition on MP3 files in class. However, this does not prevent him from seeing the management potential of bluetooth for teachers and coursework.

"I'm bluetoothing something… If we need it we regularly do that – music, pictures, videos – not course work. The teachers have no idea how to use these things – if they sent coursework to everyone so that we could copy it…Mike has bluetoothed me and I can accept it….all his files….pictures….the point is you can explore other devices and send files etc… Because the SD card from my digital camera can fit in my [device] so I can just copy and paste my pictures onto my [device] – just swap the SD card. Now I'm sending him the Bloodhound Gang song….Principally I use my [device] for music and lots of others use it for music…If you are using an mp3 it can be confiscated but if you use your [device]..."

Kieron Year 11

Schools are aware of the gap between the technical expertise of most teachers and some students. They are also aware of the challenges that 'inappropriate' uses of the device create. The communicative functions of the device were suppressed by the project at the secondary schools' request, so for example voice calls and instant messaging are not available.

Home and out-of-school

In primary there is evidence of a wide range of use of mobile devices out of school. All children report that they like having the devices and would miss them if they were taken away. However, we find that out-of-school there are both very high users and very low users who do only what is required by the teacher and keep their devices charged.

This interview extract shows how a high user spends time on 'housekeeping' to keep the files on his device organised. This is a common feature of such learners. It also illustrates how habitual use generates the kind of casual exploration described here which can lead to learning. This is very much a personal device and there is an intimacy in the way students handle and talk about the device which seems to relate to its size.

"I was doing filing. I was making sure all my stuff was where it should be. Sometimes I don't remember to save it onto my SD card so then I just check that everything's saved where it's supposed to be. If I've got some history work I don't want it saved like as a loose file I want it to be saved in my history folder. It was sort of evening. I put my [device] on charge. Then I carried on working. I went on [painting software] (I hadn't been on it for a long time) and I sort of did all these

funny shapes and stuff and decided to like blur it 'cos after I'd finished this I blurred it all in. See where it's gone all like fuzzy…so that's what I did. (Had he done this before?) Yeah I practised with it they were just like simple drawings…(How did he choose the colours?) I didn't want all the colours to be the same so I thought I'd make them far apart and different so that's why I didn't… I put a darker blue there and a lighter blue there but you wouldn't see a darker blue next to another blue so I tried to space out the colours. "

Liam Year 5

The wider context of home is emerging as an important factor in patterns of device use by learners although the effects are not predictable. In the primary phase sample, the range and amount of use out-of-school reported by students may reflect home attitudes, practices and experience in relation to technology. Where life outside school is very full and busy reported use of devices by some children may be less. However, there are also children who spend a considerable amount of time on out-of-school activities (for example those which are sport-related) who report that the portability of the device means that it is frequently taken along and used for taking photographs or video as well as for doing school-related work while travelling or during 'down time'. It was posited that mobile devices could contribute to bridging the 'digital divide' in relation to hardware access. We have found that device use in homes which are not technology-rich, can be either extensive (embraced and involving many family members) or very little beyond what is required by school. There is also some evidence that parents/carers who have technological experience and expertise can become very involved in supporting and developing device use.

Examples of parent involvement

Jack, Year 6, is active in the after school Performing Arts Club at school. He was asked to choose a poem to perform. On his mobile device he showed me the file containing The Enkindled Spirit, with date (1916) and full author credit (David Herbert Lawrence). "My dad found it for me…I typed it out. When I did it I read it off my [device]…I liked having it in my hand better than printed out on paper." Jack's teacher showed me examples of video news items created by the children using their mobile devices. Jack had decided to create a piece about [image software]. He and his dad had created a photograph which showed Jack in different places around the family car and then Jack scripted and shot his item about [image software], how it worked and what it could do.

For many weeks Danny, also Year 6, showed me animations he and his dad had made together on his device. "I have the ideas. Dad does most of it – he's mad about [animation software]." One week Danny showed me an animation he had

made completely by himself of a rocket taking off through the stars, circling the moon and zooming across the distant horizon. It mimicked one he had made with his dad but contained some individual features. It had taken him a long time to complete. He was pleased with it and his teacher made sure that (as with many examples of things produced out of school) the class was able to see and comment on the animation.

In the secondary phase the Year 10 and 11 students have so far reported little if any family involvement. Their out-of-school uses reflect their personal interests and pre-occupations. As in primary schools, students have teacher-created, self-created and supplied content stored on their devices and SD cards. They tell of using their devices in conjunction with home computers and laptops, frequently synchronising their devices with their home computers, using their computers to search the internet or write up assignments and transferring their work between home and school using the device and printing off their work. There is often a clear separation of use of devices for entertainment and education eg in terms of downloading videos and music files and placing these on separate SD cards from their coursework.

"I got loads of music from school and I got 100 odd songs and put those on my computer and I also used the [device] to put music on my phone through Bluetooth. I get it from my friends and cds that I buy so I put that on my computer and on my pda."

Georgie Year 10

Full-time ownership is blurring the divide between home and school, especially in the primary phase.

Example of out-of-school use of a mobile device. This was initiated with a teacher audience in mind but was as much for family and friends. We can see here the use a range of functions on the device and involvement of siblings in using it.

"We can make presentations and then like…and then show the teacher in school. We'd had [names software] for about a week and I made this about me. If we click here we can watch the presentation**.**"

(She shows me her presentation. It includes facts about her, her family, her friends at school, her pets and her dancing. She has also listed favourite internet sites. There are lots of photographs including one of her when she was younger which she downloaded and one of her now which she got someone else to take with her device. She also lent her younger brother the device so he could do a

drawing of her using [another software application] which she included.)

"I did it because I like to do it. I did it over a few nights and it took me an hour each night. I showed mum and dad and they said it was really clever how I could do that on my [device]."

Michelle (Year 5)

"I've seen quite a lot of that…they do things and say "Oh look I've done this." They know they've got a tool to produce a piece of work in a different way."

Primary Teacher (Year 5)

Levels of use appear not to be related to attainment or gender. The home context and the attitudes there to technology appear to be more salient. One primary school is offering after school 'clubs' for parent and child in using the device. This so far has recruited only a few parents; but the initiative was welcomed by those who participated.

Developing pedagogy

There is increasing evidence in both primary and secondary schools of integrated, critical application of the potential inherent in mobile devices for teaching and learning. In both locations teachers in schools which introduced handhelds for the first time last year (even those who started late or where the initial reception was disappointing) are showing a much more confident, relaxed and thoughtful approach to their use and value. In many cases device use is first meshed with traditional pedagogy and quite teacher controlled.

Examples of meshing with traditional pedagogy in literacy/speaking and listening.

Both Year 6 classes in the school were working on an integrated project around J.M. Barrie's Peter Pan which was also being performed by the school.

One Year 6 teacher found a piece of music software which provided examples of various rhythms and speeds. He put this on the shared drive and all the children downloaded it outside lesson time. The lesson was concerned with writing a poem (or a rap) to show what one of a pair of characters thought and felt about the other. The pairs were Peter and Hook, and Wendy and Tinkerbell. After demonstrating the software using the whiteboard, showing a teacher-made example and involving the children in some class-based composition, each child was required to write their own piece. The handheld nature of the device enabled 33 children to listen to an individually chosen rhythm. Devices were held tight against ears as fingers counted beats and tried out lines and phrases. Children

were also able to move around the class with their beats and their poems. The lesson ended with some children reading their poems aloud to the class. The audio record function of the device was not used and not all the children chose to use the word processing function to record their poems. Many used pencil and paper.

The other Year 6 teacher used the video function of the devices in group work.

The children were asked to produce a local news item in which the neighbours and parents of the Darling children were interviewed about their mysterious disappearance.

The devices enabled each group to produce an outcome with no pressure on access to cameras. One of the pupils worked out how to extend the length of video shot apparently allowed by the device. Groups produced a storyboard, script, allocated parts and roles, managed studio and 'on location' filming in the playground. Nothing was edited. All was accomplished in two afternoons.

As teachers gain confidence and respond positively to student propositions for using the devices they begin to distinguish between what they perceive as effective and ineffective ways to incorporate mobile handheld devices into their practice. Adding this digital dimension leads to shifts in pedagogy which are grounded in experience.

Extending the digital dimension: Persuasive writing coursework in Year 10.

Students had to create the text for a brochure selling Bristol to an American audience. This was approached in a variety of ways. A real leaflet was scanned by the Head of Faculty and uploaded to shared space. Students downloaded it onto their devices from the school network. They then analysed it on their devices. This was combined with print-based work learning persuasive language techniques.

Some classes completed a speaking and listening exercise at home making a radio ad using the voice recorder. They then had to write the brochure text (they were given the choice of producing this on their devices or in their exercise books). First drafts done on devices were uploaded into hand-in folders and teachers either marked them on screen or printed them and marked the hard copy depending on what they felt comfortable with. Work was returned and students redrafted and handed in final copy using a hand-in post box on the school network.

Good experiences shared as exemplars are also having an impact on practice. For instance in one secondary school students in Y11 followed the model successfully developed by the other secondary school in conjunction with the CLC earlier in the year. They used their devices to develop resources and record their work throughout the Enterprise Days in which groups developed business plans from a selection of design tasks. This activity culminated in the use of presentation software to report back what had been done.

There is more evidence of teachers integrating mobile devices with other technological tools, such as interactive white boards, and PCs, as part of an orchestrated teaching and learning activity.

Teachers are very aware of the tensions between the learning processes made possible by the device and those that have served them well in achieving the desired outcomes with their pupils. There is an understandable reluctance to abandon teaching approaches which are perceived as tried and tested, especially in assessment years. They perceive that approaches to learning that are more open-ended, learner-centred and autonomous require more time than they feel they have with a crowded curriculum and high stakes end-of-key stage assessments. For this reason, learning that incorporates use of mobile devices is often not pursued and developed and does not fully exploit the potential of the device as a tool.

Teachers are also faced with the dilemma of balancing work with the device and pen and paper activity. This is true even with conventional texts since the process of writing with a key board and inbuilt support from a word processor is different from the formation of text by hand on paper. In addition, learners (including traditionally low attainers) are showing skill and understanding in relation to the use of multi-media and the production of multimodal texts. In the primary phase this is not currently part of the end-of-key stage 2 assessment.

There is evidence that the potential for iteration, reflection and transformation that the device affords is contributing to concept development. Children have teacher-created, self-created and supplied content stored on their devices. They tell of using this at home and in class to clarify their understanding and practice skills.

Supporting iteration and transformation

In a series of science lessons on forces and resistance, groups of children designed and made parachutes of different sizes and shapes. They then designed a test to discover how long the parachutes took to fall to the ground. They used their mobile devices to record the results of the investigation in [spreadsheet software]. The results were converted into graphs and the children considered what these meant. Some graphs were shown on the interactive white

board and the whole class discussed them.

The children were invited to record what they had learned in a presentation. They were left free to decide how to do this. Most children used presentation or animation software to re-present their new knowledge in highly creative ways. The children talked about how useful it was to have this work on their devices; they said it helped them revise and they liked having it so easily accessible.

(Primary Year 6)

However, pressure of time felt by teachers to 'deliver' a content full curriculum means that activities such as these were rarely pursued to a depth and in a way that would be facilitated by the mobile devices.

Teachers are becoming more aware of the importance of a robust infrastructure and protocols for managing digital work as an aspect of successful exploitation of the potential of mobile devices for teaching, learning and assessment.

About assessment

As predicted in the early stages of the research, assessment is a key challenge.

Formative assessment and the provision of feedback to learners via the device remain challenging for teachers. Even the most confident, competent and experienced teachers working with the devices prefer to provide feedback in more traditional formats. Learners who choose to use their devices may show their work to the teacher who comments and encourages but receive no permanent record of feedback comparable to a written comment in an exercise book. Similarly work required by the teacher using the device rarely leads to formative feedback via the device. The teachers' perception is that this requires more time and is less easy to execute than writing in exercise books.

However, there are signs that where it is easy to move work between teachers and learners some innovative forms of formative and summative assessment are emerging in primary and secondary schools. The voice recording and the camera facilities afforded by the device have been employed to gather evidence of learning and provide feedback. This has proved to be useful to teachers and welcomed by learners.

Giving feedback and assessment via the device

Year 10 Students had to produce for homework a video or sound piece in character as one of characters from Of Mice and Men. These were then

handed in through the network hand-in postbox. The teacher 'marked' them orally by recording onto the device, then posted the feedback back into the post box for the students to pick up.

Example feedback from the teacher:

"Kirk- you are truly scary as Curly. I thoroughly enjoyed it and enjoyed the way you go into his character and explained his motivation in life and his priorities. I'm going to give you a high mark because you also explored his relationship with his wife which is also an important feature about how he perceives other people, particularly females. In future go for a longer time, get even more detail in there and for that piece I'm going to give an A minus – well done."

The student compares audio and written feedback:

I preferred it by voice because then I could hear what he actually thought of it because when it is written you don't know exactly what they feel but you could hear what he thought [he felt] about it… It cheered me up a bit because when it's written I feel like it's just [impersonal] and it was more personal when he directed it at me.

Capturing evidence using the device

A Year 6 teacher located screen capture software which enables children to capture a screen when they are working at home on eg Sums Online or Grid Club games. The children send the screens to him. This provides evidence of activity and when studied enables the teacher to make assessments of progress on learning out of school. This practice is being disseminated throughout the L2G project.

About professional development of teachers

Project leaders at the centre have experienced some problems in ensuring release for teachers to attend CPD sessions. Time and competing demands are issues even for the most enthusiastic, committed teachers and schools. However, a model of effective practice is emerging. This combines out-of-school sessions for training, information exchange, discussion and sharing with in-school support from project staff and more experienced colleagues. In the secondary schools in-school support from CLC staff has been an important element in the successful re-launch.

In-school support from the project.

In order to avoid connectivity issues the CLC facilitator and the English department decided it was important to have content already uploaded onto the device. Files in e-book format of the whole course book (Of Mice and Men) were uploaded; pupils used their devices to make a brochure, to connect to the network and project onto a whiteboard to copy down and have the structure in front of them. There is evidence that boys in particular are responding well and are producing more detailed writing. Exactly why this should be is under investigation.

Within this model, a number of features have been particularly effective:

consideration of the device in the context of key curriculum priorities; provision of exemplars; validation and endorsement of different uses by other teachers; validation of use from external sources such as strategy advisers.

The usefulness of authentic examples in CPD

An English teacher, decided to use the video function of the devices to help students become more aware of the criteria for speaking and listening assessments in Year 10, and to evaluate their own performance. Groups were set up and engaged in a discussion with one member using the built-in camera to capture a video record. Students first played back the video file on their devices individually and rated their performance against GCSE criteria. Then, by agreement, some files were viewed and rated by the class. Teacher and students said they found the experience useful and the teacher felt the exercise had had a positive impact on their subsequent performance.

Video of the lessons and of the devices in action, collected as part of this research, was shown and discussed at a CPD event by teachers of English from a range of secondary schools. The potential of mobile devices for English subject teaching and learning was reviewed. The enthusiasm of the Strategy Adviser and his endorsement of this potential was important in creating positive attitudes. Teachers, some of whom were previously reluctant to engage with the devices, agreed to try small-scale initiatives. Informally teachers reported that they had enjoyed the experience and were enthusiastic not only about the devices but about their potential to enhance teaching and learning in English.

A valuable extension of this model is the allocation of time for teachers to practice and experiment. Personal ownership for teachers is vital here. They need time both

to discover the potential of the device and its available applications and to feel confident in managing the integration of the device in teaching and learning activities. This is best done in the context of teachers' own classrooms and in relation to specific planning.

Schools have become increasingly aware of the importance of including Teaching Assistants and Learning Support Assistants in the initiative. They are making efforts to fund devices and training for staff working in classrooms with mobile devices.

About technical factors

To achieve the most effective integration into teaching and learning teachers must be confident that devices are available and working, and that the supporting infrastructure is robust and can facilitate the desired uses.

Technical issues with devices and even more so with the interface between the schools' wireless networks and the devices have been considerable. In the case of wireless problems it is not always clear to teachers whether the issue lies with the network or with the device. Where this leads to limited possible use over a period the spin off can be negative. However, these problems are being progressively addressed and the increased availability of loan devices for students whose devices have to be returned for repair has been welcomed by schools.

The negative impact, on teachers and schools, on contributing parents/carers and on children, of devices which fail or do not operate fully cannot be overestimated. All technological innovations experience technical problems but with the 1:1/24/7 ownership model these become more evident and more critical because there is an expectation that the technology can be called upon by everyone, at any time, anywhere.

The failure of suppliers to meet promised delivery dates has had a negative effect on plans for development in some schools. Long delays have meant that some primary schools planning to maintain a two-year cycle by equipping a new Year 5 have either abandoned the project until device procurement is stable, or had to reconcile themselves to, yet again, introducing devices late in the year.

The adoption of hard cases and the move to more rugged devices have significantly reduced screen breakages.

The ownership of mobile devices has led to an increase in the amount of work being produced digitally both in and out of school. Robust systems for the management, storage, and movement of material between teachers and learners are emerging.

Recommendations

On policy

Our research adds to a growing body of evidence that suggests that mobile devices can make a very positive contribution to teaching and learning. The main policy issues to be addressed are of sustainability and scaleability.

In relation to those issues the following points are relevant.

About support and funding

The key role taken by the initiators of both projects in this study suggest that a mass roll out will benefit from local support teams as a source of information, advice, support for schools, and in assisting schools with developing strategic responses to national and local trends. Such teams can also facilitate the sharing of effective practice.

The nature of pilot projects means that they require a level of local support that could not be provided to all schools without major investment.

In addition, models for mass adoption cannot be dependent on the same level of external support as is currently provided to pilot studies and early adopters such as those in this research. For example pilot projects can often negotiate special arrangements for licences with software companies who are keen to have their products trialled. The real costs to schools in terms of hardware and especially software should be assessed as elements of project and school budgets.

However, it could be argued that each time a new phase of a project is rolled out more is learned and there is a constant building of expertise. New schools starting with mobile devices would need support but, if lessons learned are effectively disseminated, probably not to the extent of that needed by the early participants in ground-breaking projects.

Device acquisition in the research schools has been funded by a combination of contributions from the initiating projects, parents, schools, and the e-learning foundation. It would not be possible for the e-learning foundation to extend funding to cover all schools even within one Local Authority. Schools strategically committed to sustaining 1:1 ownership of mobile devices are already facing the challenge of balancing budget priorities. The question of which funding models are scaleable is urgent.

About devices: specification, supply, services, commercial interests

There is a powerful symbiotic relationship between the industry (in terms of design, supply, cost of devices), providers (of software, content, wireless access), schools,

Local authorities and other agencies (as consumers, users, commissioners). This needs to be articulated and interrogated in relation to sustainability and scaleability of the use and potential of handheld mobile devices in learning.

It would be unrealistic and undesirable to recommend one particular device. Within this small project what is available and what is viewed as desirable is constantly changing. However, the experience of the projects suggests a core functionality of the device that is necessary for effective use and successful integration into teaching and learning. Policy around a common specification could usefully be developed. (see Appendix 1)

The capacity of the device to function successfully with a school's learning platform should be considered.

The attitude of hardware and software designers and suppliers to education as a market is a salient issue in relation to sustainability and scalability. In addition to requirements of functionality, reliability in meeting delivery times is essential to ensure continuity of development within the school and in emerging attitudes to transition. Delivering on time and providing good back-up service are paramount in achieving successful implementation.

Mutual acknowledgement of and engagement with the perspective of the industry and of education could be useful.

Equally important is the procurement of broadband wireless services/contracts. Discussions with grid and service providers at policy level is a necessary concomitant of any scaling up of mobile technology use in education.

Local authorities and schools

Ways should be found of encouraging teachers starting with mobile devices to take ownership of the initiative. Positive strategies include: consultation beforehand; provision of exemplars of mobile devices in use; discussion of the potential of mobile devices related to specific contexts and priorities; validation by external agencies.

The short shelf life of individual products, and the rapidly changing designs and specifications suggests that schools will have to deal with a range of devices over time. Schools should be prepared for changes in the devices they use and in the longer term, to address issues of specifications and in-school support as children come into school with their own mobile devices.

Provision of effective professional development and training for teachers is important in securing the smooth and successful introduction and implementation of mobile devices in schools. Teaching Assistants and Learning Support Assistants should be included.(See below – CPD)

An informed technical audit of a school's technical infrastructure, especially related to connectivity, should be undertaken, and problems resolved, before the launch of the devices. This is important with the introduction of any 1:1 rollout but the particular ease of access, instant on and mobility of handheld devices means that simultaneous demand on the system is likely to be heavy. (See below Technical)

Headteachers should consider the deployment of staff which will capitalise on the investment in professional training and assist sustainability. Greatest success has been seen where teachers have followed the devices and the pupils for two years to consolidate experience and expertise. The value of mixing experienced and novice teachers, in a year group for example, has also been valuable for sustaining development within a school.

Considering the transition of pupil users from the primary to the secondary phase is already a feature of thinking in the most mature and forward-looking of the schools. This is important if the full value of the investment of the projects, schools and families in the innovation is to be realised. Communication and collaboration between primary and secondary head teachers is necessary to develop understanding and confident commitment to the positive contribution of handheld technology to learning.

Loan devices to schools from the projects or within schools should be available in order that all learners consistently have personal access to a device.

On technical issues

These projects have uncovered those technical issues which must be resolved prior to the introduction of mobile devices.

A full and rigorous audit of wireless network capacity is needed for each location. There must be sufficient bandwidth to accommodate simultaneous access by a very large proportion of the school population. Access should be tested in each room location to identify blind spots. The compatibility of the network with the specific device should also be checked.

A school should have robust, fast, easy-to-use and secure systems for the movement of work between teachers and learners. This is a priority if time-saving management of resources and pupil work, as well as provision of formative and summative assessment are to become standard.

In the implementation phase, a high level of technical support should be provided for trouble-shooting the inevitable problems. Without this, impetus is lost, a burden is placed on teachers, most of whom do not feel equipped to cope and motivation and commitment decreases.

A technician working closely with a school to support teachers and trouble-shoot is important for effective integration. The costs involved in providing such support, especially in the early stages and in periods of change and development should be regarded as essential.

Teams of technicians involved in technological innovations should, like teachers, have a forum for exchange of knowledge and experience and the discussion of issues and problems. The time allocated for such activity provides returns in value added, for example time saved and knowledge shared.

On professional development of teachers

Processes of professional development

A degree of central control and direction is useful, especially in the early stages of innovation, but to develop commitment and a sense of ownership among teachers they should be involved in decision-making. Consultation, and opportunities for them to express their views, articulate their needs and share their experiences have been productive.

A model of CPD that combines out-of-school training and development with in-school support from the centre and from colleagues is recommended. In-school support is especially valuable when it is proving increasingly difficult to arrange for teachers to attend out-of-school training, even when cover is provided.

Encouraging teachers to undertake small-scale initiatives which they then review, evaluate and share with other teachers has been productive.

The development of communities of self-supporting teacher users within schools and between schools should be actively encouraged and facilitated as an aspect of sustainability. The spontaneously occurring networks among student users could be considered a useful model.

Content of professional development activity

Beyond an initial focus on understanding technical aspects of the device and developing competence and confidence in use, CPD should focus on understanding the potential of the mobile device as a tool for learning. The approach should be through the consideration of learning and planning and managing teaching; using the criterion of matching use to desired outcome.

Managing assessment should be a key focus, especially the development of ways of moving work between teacher and student and providing feedback and formative assessment in a permanent format to encourage learner reflection.

The potential of mobile devices as a tool to support an approach to learning based on iteration and reflection should be considered. Issues around time available, nature of formats for outcomes, possible conflict with current standard assessments should be addressed

Issues around increased pupil autonomy in class should be articulated and addressed. In addition, increased awareness by teachers of levels of autonomous use out of school by learners would be helpful in avoiding a ‘digital experience divide’. The provision of the device may not be sufficient for some learners.

Pre-prepared content and activities made available centrally can help teachers to think about incorporating mobile devices in their planning. The provision of exemplar approaches developed by teachers is helpful in encouraging buy-in. Video from exemplar lessons has proved especially effective. Opportunities for teachers to share experiences of using these resources and to consider the learning processes and outcomes they facilitate are valuable and make a positive contribution to professional development. Such an approach to CPD is appropriate as a project develops beyond basic learning about the tool. It also provides a strong evidence base for the contribution of mobile devices to learning.

Appendix 1

Specifying functionality

What does a handheld device need to be able to do to enable effective use in an educational setting?

Drawing on a range of sources, the following functions appear to be important in use. We have also indicated where the emphasis is different in the primary and secondary phases

Hardware

- battery life of at least five hours
- instant on and off
- sufficient memory (augmented by portable memory such as SD cards and by interaction with space on a school network)
- internet browser and access (for research, downloading, uploading)
- ability to beam/Bluetooth
- ability to synchronise/interact with other digital tools
- the appropriate ergonomics (of portability and fit for the hand-size) for out-of-classroom use
- size and clarity of the screen eg a VGA resolution screen has enabled users to work easily on a 3.8 inch screen
- the ability to link to an external keyboard (to support personal choice in varied writing/recording situations)
- camera - still and video (seen as essential in primary; many secondary students reported preferring to use their mobile phones for images)
- the device must be rugged enough to withstand classroom use and travel between home and school

Software

- Word processor
- Presentation software
- Spreadsheet
- Class management software to enable screen sharing on the whiteboard and to give teachers access to screens
- Reader to support making/using e-books
- Animation/storyboarding software
- Painting programme (valued most in primary)
- Concept mapping (valued most in primary)

- A learning environment or content management tool to support the aggregation and management of work
- Screen capture software
- Appropriate subject specific content/software (especially in secondary)
- 'Practice'/games content/software. (Seen as especially valuable for maths.)

What level of wireless connectivity is the minimum requirement for effective use?

There has to be sufficient bandwidth for all users to be online simultaneously. All schools had to make adjustments when problems (which might have been avoided with prior diagnosis) occurred.

The technical adviser to the Bristol CLC project suggests one wireless hub for 12 users. L2G suggests one good quality router per class should be sufficient.

Our evidence suggests that the criterion of match/suitability to need is the most salient. For this reason a proper understanding of the potential of different functionalities is important, However, they are bundled into a device. Devices are changing and developing rapidly.