

Researching mobile learning

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Summary

This report brings together the findings from the third phase of a two-year development and research project that focused on the impact of one-to-one personal ownership of mobile devices. This report focuses on two areas that have emerged from the analysis as important in relation to impact:

- Students' use of and attitudes to their mobile devices
- The professional development of teachers.

The research was carried out in partnership with primary and secondary schools in two local authorities. Handheld devices were given to all pupils in a year group. Here, we report and discuss our findings from the data collected from students in Years 6, 7 and 10 and 11. The section 'Learners as users' reports what learners said about when and why they use devices. In 'Users as learners', we look specifically at the learning-related aspects of the data and discuss emerging patterns and issues related to the use of devices.

As the research progressed and technical issues were identified and addressed (although not completely), the levels of device use by teachers in lessons emerged as having a significant effect on the degree to which students successfully exploit the potential of devices in their learning in and out of school. In this phase, we sought explanations for variations in teachers' take-up of devices, and in particular we aimed to highlight approaches to professional development that have been effective. The section 'Teachers as users' reports our findings.

Two earlier reports from the same research project were published in July 2007 and January 2008:

- *Mobile learning: Research findings, July 2007* (McFarlane *et al.*, 2007)
- *Researching mobile learning – Interim report to Becta, April – December 2007* (McFarlane *et al.*, 2008)

You can find all Mobile 1:1 reports on the Becta website.

This report will be of interest to those engaged in the provision of technology for learning, particularly policy makers at all levels and school leaders.

Key findings

Learners clearly associate the use of handheld devices with learning, in school and out of school. Moreover they see the devices as supporting effective learning. This perception is not dependent on level of use and persists over time; it is not a novelty effect.

Patterns of use of devices vary, with some learners becoming enthusiastic and frequent users for learning and other personal purposes in and out of school, and other students in the same school making relatively little use of their devices.

Level of use is not associated with overall attainment level. Some high-level users achieved beyond their predicted levels or grades in end-of-key-stage assessments; others did not. Similarly, some low-level users exceeded their predicted attainment levels or grades, and others did not.

Teachers continue to play a key role in pupils' uptake and use of devices, both in school and out of school. When teachers make regular use of devices in class, a majority of learners will also use the devices, both under direction and autonomously, in and out of class, for school-related purposes and non-school-related purposes.

When learners show low levels of use of the devices, this may indicate low motivation but is also strongly associated with a lack of knowledge of how to use the device – a lack of competence in using the device is a major barrier for some pupils who fail to use their devices even though their teachers encourage them in class. The idea that young people will learn to use a technology for themselves is unhelpful. The data gathered over two years show that only small numbers of learners spontaneously begin to use devices for any purpose – in or out of school. The attitudes to and patterns of use in homes and in peer groups, combined with the availability of support for gaining expertise in both these contexts, constitute a key variable in the development of use of devices. Unskilled low users do not work out how to operate the devices, nor do they seek out tuition, for example from technicians or other learners; they are more likely to become dependent on others to achieve the minimum level of use required. There is a need to identify these learners and provide support to make sure they know how to operate the device competently.

Attributes of the device associated with effective learning and valued by students include that it:

- facilitates individual, co-operative and interactive work in class
- enables the sharing of ideas and responses and the building of knowledge
- increases participation in whole-class settings
- enables learners to revisit areas for consolidation and reflection out of the classroom – this helps to increase understanding
- provides opportunities for autonomy and independence
- provides work and resources in one place, and to hand
- gives the ability to transfer work between digital devices and to and from other areas such as shared drives and learning platforms
- alleviates pressure on the computer rooms and makes learning more flexible.

Learners are often sophisticated users, making informed choices about when and when not to use their devices. Their conclusions about the device may, however, be very different. For example, some learners prefer to use the device to produce text; they use spell check and predictive text, incorporate images in their work, value the appearance of this work, and find using the device easier than handwriting. Others prefer paper because they find it easier to use and think that they need to practise handwriting; this preference may also be associated with poor keyboard skills and a belief that the screen of the device is too small. These learners with their different approaches may be in the same school and even the same class.

Most learners value the ability to access the internet for research using the device. This is true in primary and secondary schools. The only pupils who do not seem to value this ability to access the internet have high levels of access to very good alternative technologies in their homes.

Teachers' attitudes to device use vary, even within one school in some cases. It is clear that most teachers need to be shown effective examples of how the devices can be integrated into lessons. Teachers who innovate with devices are exceptional; supporting these teachers to share their insights provides benefits to all those involved in a project. Moreover, providing opportunities for teachers to work with those who can offer technical and pedagogic insight and support has resulted in major breakthroughs and the development of new applications for device use.

Background

The research was located within two ambitious initiatives: Learning2Go, a local authority initiative in Wolverhampton, and Hand-e-learning, a city learning centre initiative in Bristol. These projects enabled all pupils in a year group and their teachers to have mobile devices. The teams of professionals at the local authority education support service in Wolverhampton and at CLC3, a learning centre in Bristol, have been essential to the projects, providing vision, leadership, professional development, advice and technical support.

Three primary schools and two secondary schools were involved in the research. In all cases, the headteachers showed significant commitment to the vision of embedded use of technology in the school through the use of personal mobile devices.

In this third phase of the project, the school pupils with devices were in Year 6 and Year 11, had been part of the research since the beginning. Pupils in Year 7 and Year 10 had joined the project at the beginning of Phase 2 (September 2007). This extension of the sample was caused by changes to the secondary school project, which had experienced some setbacks and was re-launched with a different device. Year 11 students in both schools continued to own and be allowed to use the devices they acquired in September 2006 (the beginning of the project).

In all cases reported here, the devices were funded by parental contributions linked to grants from the e-Learning Foundation. The learners had full-time ownership of the devices, including at weekends and during 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). Each of these devices 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 one working day; battery life was considered by primary and secondary schools to be an important criterion in device selection. Devices were wireless enabled, and all schools involved had wireless access.

The device chosen for the re-launched secondary project was a mini clamshell-style device with a larger screen and in-built keyboard. Like its predecessor, it had a camera, but it came with a higher specification system; it also had increased storage and 3G connectivity. The city learning centre entered into a contract with a major service provider for data services and loaded onto each device a profile designed to suit the learning needs of the users.

The research

Students' use of and attitudes to their mobile devices, and the professional development of teachers were the focus for data collection in this third phase of the Mobile 1:1 project.

The design of the research project was developmental in that data were progressively analysed and findings fed back regularly to teachers and headteachers for their validation and comment. The researchers' role, initially, was to record and provide a mirror. As the project progressed, teachers, as co-researchers, were invited to make a contribution to the analysis of data and the creation of knowledge. The findings were shared with and validated by all involved, and the research fed into developments in implementation and practice.

Surveys, observations and interviews focused on learners throughout the research period show clearly that there is considerable variation in the reported frequency of device use in and out of school. Our work in the third phase of the research has been to understand better the factors that produce such variations and to assess as far as possible the impact of higher and lower frequencies of use on learners and learning.

For more detail on the research design and methods, the schools and the sample of students, see Appendix A.

Data sources and methods

In March and April 2008, learners in Years 11, 10, 7 and 6 were surveyed to investigate their pattern and frequency of use of the mobile devices. The results were fed back to schools and projects for comment.

Establishing the frequency and the purposes of device use was important for the research. The research asked (in different ways) about use in and out of school. Indications of time spent using the device are not necessarily indications of time spent learning using the device. Observation and follow-up interviews suggested that some in-school use (eg before lessons begin and at lunchtime) is not directly related to learning. Students may be listening to music, using Bluetooth to exchange files (usually images), playing games or using instant messaging. For this reason, we also asked learners to report separately levels of use related to school work, learning and for personal use.

Based on the survey, learners were categorised as high, medium and low users in and out of school and for different purposes. We selected a representative sample of these learners for interview. The interviewer began by checking the student's view of the accuracy of the suggested frequency of his or her use, and noting any changes in attitude or explanation since the survey. Audio and/or video interviews in June and/or July with students in Year 7 (13 students) and Year 10 (16 students), Year 6 (45 students), interviews with teachers and project staff, classroom observations and

video recording, and attainment data from Year 6 and Year 11 all contributed to the findings.

Learners as users

Technological context at home in 2008

The baseline survey in 2006 established that at home, most students had access to a wide range of new technologies. This had not changed in 2008. Levels of personal ownership of mobile phones, iPods/MP3 players, and games consoles of different kinds were high across all schools and year groups. In Years 6, 7 and 10, between 73 per cent and 86 per cent of students reported that they own a mobile phone. The highest levels of ownership were in Secondary School E Year 7 (86 per cent) and Primary School C (81 per cent). Between 58 and 78 per cent of families have a digital camera and around a third of students in Years 6, 7 and 10 said they own a digital camera. In Year 11, around 80 per cent of students reported that they own a digital camera, although this may be linked to mobile phone ownership. These findings are generally in line with those for populations of similar ages in other published research.

In considering the ways in which personal ownership of a mobile device with internet access may be having an impact on students and their families, we were particularly interested in the access at home to a computer and to the internet (see Table 1).

Table 1: Computer and internet access reported in 2008

	No computer access %	Shared computer access %	Own computer %	No internet access %	Internet access %	Broadband/wireless access %	N
Primary A Year 6	6	70	24	15	85	73	34
Primary B Year 6	0	28	72	0	100	72	18
Primary C Year 6	4	54	24	16	84	73	57
Secondary D Year 10	0	55	45	10	90	72	119
Secondary D Year 11	0	38	52	15	85		68
Secondary E Year 7	0	54	46	3	97	72	92
Secondary E Year 11	0	40	60	3	97		131

Only four students in Year 6 reported that they have no access to a computer at home. Over the whole sample, 32 students (6 per cent) said they have no access to the internet. The cost of internet access is a factor for most of these families; however, there were individual homes where one or more adults expressed antipathy to computers and, in particular, to the internet.

Interviews revealed that the ownership of mobile devices is valued where:

- computer equipment at home is out of date and unreliable
- there is competition for computer use with siblings
- the individual student is low in the pecking order for access to the computer.

The interviews also provided evidence of the positive effect of ownership of devices with 3G facility and funded server access on students who previously had no access to the internet. Students felt less excluded, because they could now actively research topics for school at home – something they cited as helping them in their

work; some students in Year 10 thought this had transformed their approach to learning. (Teachers also mentioned increased motivation and better organisation as aspects of changed learning behaviour in connection with these students.) Internet access also enabled students to be part of the social activity of downloading games and music, and accessing popular sites.

Reports of the impact on the family of having internet access varied. In some cases, internet access was transforming, with every family member making use of the device in and out of the home. In other cases, there was little reported use of the device by others for internet access; reasons given included being too busy with a new baby, being at work, not being interested and not believing in the internet.

Evidence overall of the effect of device ownership on families was provided by responses to the question 'Does anyone else at home use your device?' (see Table 2).

Table 2: Use of devices by others at home

	Often %	Sometimes %	Never %
Primary A	21	44	35
Primary B	17	61	22
Primary C	11	33	56
Secondary D Year 10	6	50	44
Secondary E Year 7	16	43	41

Devices appear to be integrated to some extent in the home and family life of between half and three-quarters of the students in the survey. More limited reporting by children in Primary School C of devices being shared may be a result of their feelings about the device: in interview, some children said they are reluctant to allow siblings to use the device because they may damage or break it.

Frequency of device use in and out of school

Two questions in the survey were designed to identify the frequency with which students make use of devices in and out of school and extent to which they do so.

The first question related to use of devices in and out of school in the previous two weeks. In the rare cases where the previous two weeks had been atypical for any group, students were asked to think of a typical two-week period. The question provided a range of measures of use: six or more times a day, two to five times a day, once a day, once every few days, once a week, or no use. For the purposes of this analysis, the first two frequencies were combined to identify high users, the second two to identify medium users, and the last two to identify low users (see Table 3).

Table 3: Frequency of device use reported in and out of school

	High in school %	High out of school %	Medium in school %	Medium out of school %	Low in school %	Low out of school %
Primary A	70	42	24	42	6	15
Primary B	28	17	56	39	16	44
Primary C	55	54	45	40	0	6
Secondary D Year 10	49	52	45	33	6	15
Secondary E Year 7	9	33	77	48	14	19

Students reported varied amounts of use in and out of school. A large majority of the students perceived that they use their devices in school at least once every few days, and in many cases much more frequently.

The follow-up interviews and other data sources indicate that for some students the mobility of the device is a factor in self-initiated out-of-school use. Students referred to using the device in the car, while waiting for someone or something, in a restaurant, to show work to other family members in their homes, and on holiday. We have some limited evidence of teacher-initiated device use out of the classroom, within the school or in the school grounds, and, in the primary phase, of off-site use during school camp.

Responses to other questions in the survey, the follow-up interviews and other data sources were used to explore further and explain these variations – see the section ‘Users as learners’.

Reasons for device use

To help us explore the relationship between use for school work and personal use, we asked students to report their frequency of device use for school work in and out of school, and for personal purposes in and out of school (see Table 4).

Table 4: Frequency of reported device use for school work in and out of school

	For work in school			For work out of school		
	Often %	Sometimes %	Never %	Often %	Sometimes %	Never %
Primary A	53	47	0	32	50	18
Primary B	55	45	0	17	66	17
Primary C	88	12	0	32	50	18
Secondary D Year 10	54	41	5	24	50	26
Secondary E Year 7	28	72	0	17	60	23

Only three students from the whole sample said they never use their devices for work in school. More than half the students in three of the schools, and almost 90 per cent in one, thought they use their devices often for work in school. Students responding from Secondary School E were more likely to say that they use the device sometimes rather than often.

The pattern of responses for using the device for work out of school is much more varied, with fewer students saying they use it often, and more saying they never use it. Though the numbers in the primary schools are small, in secondary schools, almost a quarter of students were in the 'never' category. We looked for explanations of this variation – see 'Users as learners'.

Table 5 shows the reported frequency of device use for personal purposes in and out of school.

Table 5: Frequency of reported device use for personal purposes in and out of school

	For personal use in school			For personal use out of school		
	Often %	Sometimes %	Never %	Often %	Sometimes %	Never %
Primary A	29	53	18	29	56	15
Primary B	17	72	10	45	45	10
Primary C	14	63	23	43	37	20
Secondary D Year 10	31	35	15	56	34	10
Secondary E Year 7	16	49	35	35	35	30

Levels of device use for personal purposes in school are affected by the opportunities available. In Primary School C, for example, devices are generally collected during breaks, for security, and use in the playground is not encouraged.

In interviews, students who reported using devices in school said they did so before school and in breaks. Evidence from interviews and in-school observation shows that students share files with friends (most frequently they download music, pictures or games) and show friends their photographs. Primary children show each other things they have created out of school for fun, such as animated or slide sequences. Secondary students more frequently access instant messaging applications.

Overall, our analysis does not find a simple association between frequency of use in school and out of school for whatever purpose. Patterns of frequency of use and for different purposes are varied. However, the levels of use reported for school work or learning in and out of school often reflect those reported for personal use in and out of school. High levels of reported use in school (for whatever purpose) are associated with high levels of reported use for school work or learning out of school. High levels of reported use for personal purposes out of school are often associated with a high reported frequency of use for school work out of school. In contrast, high levels of reported use for personal purposes out of school are sometimes associated with a low reported frequency of use in and out of school for school work or learning. The numbers who said they never use the device for personal purposes are very similar for in and out of school. The research continued to try to find explanations for these variations.

Specific purposes for device use

The survey offered a list of 26 activities that the devices may be used for and asked how often the students engage in any of these activities. Table 6 shows the activities that over 50 per cent of the year group said they do often.

Table 6: Device uses cited as ‘often’ by at least 50 per cent of the group

Primary A	Primary B	Primary C	Secondary D Year 10	Secondary E Year 7
Search the internet	Learning in class	Learning in class	Listen to music	Search the internet
Learning in class	Search the internet	Play games	Search the internet	Play games
Play games	Beam files to teacher	Search the internet	Learning in class	Beam files for personal use
Take photos	Download files from teacher	Beam files for school work	Beam files for personal use	Take photos
	Make presentations	Use the calculator	Play games	Learning in class
	Take photos	Take photos	Take photos	Listen to music
		Make presentations		
		Beam files for personal use		

Frequency of use for learning in class is consistent with other responses. The device as a learning tool appears to be well integrated into activity by a majority of the students in each setting. Not surprisingly, searching the internet is the most consistently mentioned activity across all groups. Playing games and, in the secondary contexts, listening to music are also widely mentioned, as is the use of the camera to take photographs. Given that, when talking about playing games, primary school children always consider learning games provided for them on the device to be games, and that taking photographs is often part of classroom activity, it could be argued that this list consists mainly of learning-related activity; this is further evidence that, for a majority of these students, the device is perceived as a tool for learning.

Table 7 shows the activities that over 50 per cent of the year group said they never do.

Table 7: Device uses cited most as ‘never’ by each group

Primary A	Primary B	Primary C	Secondary D Year 10	Secondary E Year 7
Download files from teacher	Synch device with another computer	Synch device with another computer	Organise and back up files	Organise and back up files
Synch device with another computer		Organise and back up files	Plan work	Synch device with another computer
Send files to teacher			Synch device with another computer	Plan work

Between one-third and two-thirds of students in each school said that they never synch their devices with home computers or laptops. This, combined with the infrequent use of Active Synch reported elsewhere in the survey, suggests that students may not be exploiting the mobility of the device and its potential for use in combination with other technological tools in and out of school. However, reported use of Bluetooth is frequent, and many users said they prefer this method of transferring content between, for example, their PDAs and their mobile phones. More than half of secondary students reported never organising or backing up files or using the device to plan work. This suggests that there are aspects of device use and potential for learning which can be further developed.

Few learners in the primary phase use the Connect function on the device to switch between wireless access at school and at home. Schools are reluctant to explain this possibility to users, because home internet access is outside the protected internet environment of the school. However, it is clear from interview data that some students, primary and secondary, are finding their own way around this, sometimes with the help of friends or family members.

Device use across the curriculum

Students were asked to identify in which subjects teachers asked them to use the device in class and for homework. Table 8 shows the findings in primary schools.

Table 8: Students' views of the subjects in which primary teachers required use of devices in class and for homework

Subject	Primary A		Primary B		Primary C	
	Teacher asked class %	Teacher asked home-work %	Teacher asked class %	Teacher asked home-work %	Teacher asked class %	Teacher asked home-work %
Reading	71	38	78	50	98	21
Writing	50	44	83	22	70	28
Maths	71	35	88	61	93	40
Science	71	38	83	28	84	28
History	71	32	72	22	82	28
Geography			72	11	56	9
PE	71	12	94	11		
RE	71	21	94	33		

PE = physical education; RE = religious education.

Students more consistently reported that device use is required in class, and to a greater degree, than for homework. We observed that, for homework especially (although also in some class activity), teachers give students a choice about whether they use their devices; this may explain the greater use of devices in class.

Table 9 shows, for secondary schools, the subjects in which teachers asked students to use their devices in class and for homework.

Table 9: Students' views of the subjects in which secondary teachers required use of devices in class and for homework by subject

Subject	Secondary D Year 10		Secondary E Year 7	
	Teacher asked class %	Teacher asked homework %	Teacher asked class %	Teacher asked homework %
English	80	41	44	26
Maths	26	22	24	5
Science	33	14	20	9
BLP			43	28
PSHE	42	13		
Citizenship	18	5		
B studies	11	0		
PE	11	6		
RE	17	6	11	3
History	3	2		
Geography	5	6		
MFL	10	3		
Drama/Dance	6	4	12	4

BLP = Building Learning Power; PSHE = personal, social and health education; PE = physical education; RE = religious education; MFL = modern foreign languages.

Even allowing for an element of error in students' recording of their device use across the curriculum, this table indicates the varied take-up by teachers within the same subject department and in different departments across schools. As we have noted in previous reports, the integration of mobile devices into learning in the secondary phase is more complex and problematic than in the primary phase. Some teachers make much more use of devices in class than others (see 'Teachers as users' for discussion of the variations in use by teachers). The difference between students' perceptions of how much teachers require devices to be used for homework compared with in class suggests that in the secondary phase also, students are being given a choice about whether to use or not use a device for homework tasks.

Table 9 also reflects the chosen focus for professional development of teachers in device use in the two schools, and use of devices in previous years. Professional development for teachers in Secondary School D was mainly concentrated in the

English department. Teachers of PSHE also expressed an interest in the devices and received support in developing a work experience module incorporating device use. In School E, the focus was on the Building Learning Power course, which the school had introduced in Year 7. Members of the English department were also present at some of the training for teachers in School D. In both schools, there was a legacy of involvement in science, which is evident in the continued use of devices by some science teachers. (See 'Teachers as users' for more detail.)

Evidence from interviews with students in Secondary School E indicates that when survey responses were collected in spring, more teachers were experimenting with incorporating devices into teaching and learning. The students reported a marked fall-off in the amount of required use of devices since the survey. This pattern is observable generally in the data from secondary schools. Reasons for this fall-off, and strategies for responding to or avoiding it, are discussed in 'Teachers as users'.

Students were also asked to indicate the degree to which they choose to use devices in class and for homework; Table 10 shows the data for primary schools.

Table 10: Autonomous use of devices, reported by primary students in class and for homework by subject

Subject	Primary A		Primary B		Primary C	
	I chose in class %	I chose for homework %	I chose in class %	I chose for homework %	I chose in class %	I chose for homework %
Reading	44	15	11	11	12	35
Writing	32	21	44	88	10	23
Mathematics	29	18	11	16	21	46
Science	15	9	0	11	10	39
History	41	15	11	5	16	25
Geography			11	0	7	16
PE	15	6	16	0		
RE	23	6	5	5		

PE = physical education; RE = religious education.

Table 10 shows the considerable variation in students' reported autonomous use of devices in different subject areas at different times. There is relatively little evidence of autonomous use in class in Schools B and C, except for writing (School B) and, to a lesser extent, mathematics (School C). Teachers appear to exert a higher degree of control over device use in Primary School C than in Primary School A, where a

greater proportion of children say they exercise choice in several subject areas. However, the number of children choosing to use the device for homework is greater in School C, which suggests that children are encouraged to choose to use devices for homework if not in class.

Table 11 shows students' reported autonomous use of devices in secondary schools.

Table 11: Perceptions of autonomous use of devices made by secondary students in class and for homework by subject

Subject	Secondary D Year 10		Secondary E Year 7	
	I chose in class %	I chose for homework %	I chose in class %	I chose for homework %
English	27	20	7	7
Maths	13	7	3	3
Science	40	11	3	2
BLP			7	11
PSHE	24	9		
B studies	3	3		
PE	6	3		
RE	12	5	2	2
History	3	2	3	3
Geography	6	3	2	2
MFL	10	6	9	7
Drama/dance	16	3	2	2

BLP = Building Learning Power; PSHE = personal, social and health education; PE = physical education; RE = religious education; MFL = modern foreign languages.

The Year 10 students appear to be making much more autonomous use of devices than those in Year 7. Both sets of students acquired the same new device at the same time. The pattern of data here suggests that where teachers make use of devices in class or for homework, students are more likely to employ them autonomously for school work. Our interview data and observations also suggest that teachers who plan for device use are also more inclined to encourage (or at least not discourage) students who pick up their devices in class. Students reported that some teachers actively discourage them from using devices in lessons. Students' levels of confidence and skill in using their devices also play a part in the

amount of autonomous use for learning or any other activity (see 'Users as learners').

Attitudes to mobile devices

A final section of the survey asked students to indicate the extent to which they agree with a number of statements. Table 12 combines figures for 'strongly agree' and 'agree' responses.

Table 12: Attitudes to mobile devices – measures of positive responses

	The device has helped me with my learning %	Using the device makes learning more enjoyable %	My family are pleased I have the device %	I show school work I have done on the device to my family %
Primary A	91	91	74	62
Primary B	77	77	50	50
Primary C	97	96	80	76
Secondary D Year 10	77	79	63	45
Secondary E Year 7	65	94	68	37

In four of the schools, over three-quarters of the students thought that the device helps them with their learning. There was general agreement that using the device makes learning more enjoyable. This echoes all the research on the motivational effects of mobile technologies. It is worth noting that for the primary students after two years, and for secondary students after one year, the positive view remained, even though the devices ceased to be a novelty and became, for many, an established tool.

In primary schools, there seems to be an association between students showing school work on the device to their families and students reporting that their families are pleased the student has the device. Figures for family approval and showing work are lower in the secondary schools. However, the fact that nearly half of Year 10 respondents said that they show work on the devices to their families is remarkable given the usual reluctance of students of this age to want their families to see any of their school work.

Students were also asked if they would recommend that other students should have mobile devices to support their learning, and to explain the reasons for their choice.

Between 87 per cent and 96 per cent said 'yes, definitely' or 'yes, possibly'. It was clear that students could see the benefits and potential of device ownership: explanations for their 'yes' answers consistently featured the words 'help'/'helpful', 'fun'/'enjoy'/'enjoyable', 'interesting', 'easier', 'useful' and 'handy'. Internet access (not having to go to the computer room or compete for the computer with siblings at home) was also mentioned. Many pupils generalised from their own positive experiences and suggested that the devices would be good for other students. Some touched on the social aspects of learning and the blurring of boundaries between home and school.

Those who chose 'yes, possibly' gave two kinds of caveats: students were concerned about not using (or being allowed to use) the devices more in learning; also, they would recommend the device to others if it was used by teachers. Students were also aware of the technical problems they had encountered and would recommend only a device that was reliable and robust. Some recommendations were conditional on freedom to access more websites and/or programs; students expressed irritation that so many websites and programs are barred in school.

Users as learners

The survey data indicate that learners have positive and enthusiastic attitudes towards the device. A large majority of learners (almost 100 per cent in two of the primary schools) said that having a device has helped their learning and made learning more enjoyable. Learners used words like 'helpful', 'fun' and 'easier'. The new devices in secondary schools were described as being 'like a mini computer', 'like a laptop but a lot more powerful' and 'a lot lighter and easier to carry around', and students commented that the device 'is always to hand' and 'really good for researching'. Other data sources indicate that the comparisons being implied were not only with other computers but also in some cases with using pen and paper, textbooks or worksheets. In the primary phase, learners thought that using the device meant being more active, which was perceived as more fun.

More generally, the role of the device as an alternative to a computer with internet access ('always to hand', 'good for researching') was valued. In the classrooms of the students in the study, access to desktop or laptop computers was limited or non-existent. (For information about the wider technological context in each school, see Appendix A.)

A strong sense emerges from the data of a group of students appreciating and using the potential of the device for personalising their learning, becoming more involved and independent. Equally strong is the sense of some teachers, for example the English teachers in Secondary School D and the primary teachers in Primary Schools A and C, productively exploiting the learning potential of the device to engage and support students. In general, these developments are perceived by learners as helpful to their learning, as well as being enjoyed.

Although there were wide variations in the amount of device use by learners, most, whatever their level of use, had a positive view of devices as a support for learning. Learning processes associated with the device that appeared to be valued by students in both phases are that it:

- facilitates individual, co-operative and interactive work in class
- enables the sharing of ideas and responses and the building of knowledge
- increases participation in whole-class settings
- enables learners to revisit areas for consolidation and reflection out of the classroom – this helps to increase understanding
- provides opportunities for autonomy and independence
- provides work and resources in one place and to hand
- gives the ability to transfer work between digital devices and to and from other areas such as shared drives and learning platforms
- alleviates pressure on the computer rooms and makes learning more flexible.

Students reported different levels of out-of-school use for learning and personal activity. Many students made extensive use of their devices for their chosen purposes. However, the data overall suggest that the device was seen mainly as a learning-related tool; this reflects the message that the schools have been actively promoting.

Characteristics of learners who report high and low levels of device use

High users

The Year 11 students' experience of mobile devices was predominantly negative – these learners were part of the unsuccessful pilot launch in 2006. However, the survey responses identified a small band of determined and dedicated users who persisted with their devices into Year 11. In our first report, we noted these students as 'enthusiastic and knowledgeable users (who) seem to make more spontaneous use of the devices to support their own learning, and cannot understand why others do not'. Given the lack of use by most teachers, the students were most likely to be using their devices independently.

In all years being researched, there were students with a fairly sophisticated understanding of what the device can do, who have ideas about how it can be used to support their learning. Individuals in both primary and secondary phases were interested in downloading software and upgrading the device.

High users who were less expert said that the device had an impact on their ability to organise themselves. Some, as our observations and video data show, made extensive use of features such as alerts and tasks; some used the device in conjunction with print-based planners, timetables, notes, and so on.

Positive gains reported by high users were: better grades, increased ability to concentrate, improved self-organisation, more work done at home, and changed attitude to a subject. High users were found across the attainment range.

Summarising from the data, we can say that high users:

- relish, enjoy are proud of owning a PDA/EDA
- are confident, and are active in developing their skill in using the device
- appreciate the potential of the device and seek to use it
- explore what the device can do
- are proactive in seeking new device-related knowledge and sharing it
- download software for the device
- like to be autonomous and have opportunities for controlling learning and device use
- use the PDA in association with other digital devices such as computers, mobile phones and other PDAs/EDAs
- are thoughtful about how the device might be incorporated in learning.

Low users

Many low users reported little confidence in their ability to manage the device and little understanding of how it works and what it can do:

“There are still things I don’t know about (it). Sometimes it says ‘you can’t open this’ and I just leave it ‘cos I don’t know what to do.”

Summarising from the data, we can say that low users:

- are not proactive or inclined towards autonomy; they use their device only when directed
- have only a basic level of skill with and understanding of the PDA
- are happy to be dependent on others
- may have no access to support from more experienced or enthusiastic users
- have inaccurate perceptions about provision, systems and what the PDA can do
- have little exposure to PDA use in class or for subject learning generally
- may have experienced technical problems which have not been resolved.

Factors affecting levels of device use by learners

Variations in the frequency of use by learners in and out of school are a result of a number of different factors.

Reasons related to teachers

Learners in classes where the teachers make use of the device tend to report using it more for work out of lesson time. There appears to be a tacit assumption about expectations and appropriateness, which students infer from teachers' behaviour. Our research so far suggests that students use their devices more independently and productively when their teachers use devices in lessons and demonstrate their potential.

Learners who have limited experience of using devices in formal learning contexts are less likely to become the kind of skilled and confident users who use the tool frequently and effectively. Observations in the primary classrooms showed the device always present and ready for learners to use when directed by the teacher or (when allowed and encouraged) independently. The observed classes made use of the device, although the amount of planned whole-class use varied between teachers.

Students in the secondary schools reported that teachers instigated different levels of planned PDA use in lessons, both across and within subjects. Reported experience of required or optional PDA use for homework was more frequent, but levels still varied. Teachers' attitudes to autonomous use of PDAs in class varied from encouraging, through limited tolerance to outright prohibition. Where there was no expectation of use in class, students – even high users – began to leave their devices at home.

Use of the device for homework (and sometimes in lessons) was frequently offered as a choice in both primary and secondary schools. Some students never took this option; some did sometimes; others always did. Students who said they have little confidence in device use and little understanding of how the device works told us that they were given the opportunity to use the device for homework but didn't take it. When a large amount of use is delegated to students working independently out of school, there is an impact on students who are less skilled and confident and who have limited access to help and support.

In the primary school, we saw confident, high users choose to use their devices or request permission to use them. The device was used as a tool, for example for making notes, recording, planning, brainstorming, storyboarding, looking things up, looking back over work, and photographing the whiteboard. When asked, teachers, as a rule, encouraged use.

Students' attempts at autonomous use of devices in secondary classes were rarer. When asked how their teachers would respond if they did want to use the device in lessons, secondary learners' answers varied. Most expected to have to ask permission. Some teachers, they suggested, would think it was a good idea. More teachers, they thought, would have a negative response and ask them to put the devices away, or remove them.

Reasons related to home context and personal preferences

The technical context at home – access to hardware, the range of devices available (laptops, desktops, digital cameras, mobile phones, MP3 players etc), their speed of operation, the programs available, and ease of use – had an impact on the frequency of use of the device. For example, many expert users made little use of the device out of school because they preferred to use other types of technological device. The most frequently mentioned reasons for not using the device were: the PDA is slow; the PDA screen is small; prefer using the computer keyboard; computer has a higher specification than the mobile device and is easier to use. Conversely, some learners used their devices because the devices have more programs than their computers or are faster. They liked the small size and the mobility of the device.

Fear of losing the device or having it stolen limited how much some users exploited the mobility of the device. The situation regarding insurance and liability was varied and not always clear.

The attitudes, experience and expertise of family members and friends affected attitudes to the device and levels of use. Discourse around the device, and its integration in family life, were associated with high usage. Access to a social group (family, friends or both) where help and support was available was important in developing skill, understanding and confidence with the device. Students without this social support were less confident, adventurous and skilled, and tended to be lower users.

Reasons related to students' choices about ways to learn

In addition to evidence about decisions not to use a device that are based on lack of confidence and skill, we also have evidence that some students, when deciding whether to use a device, made a conscious choice about how to engage with an activity to learn something effectively. The choice could be seen as an opportunity for personalisation, with students enacting their preferences for ways of learning – preferences that may (or may not) favour the use of a mobile device. For example, for one Year 11 student, downloading presentations (used by teachers in the lessons) from the school's shared drive was seen as positive:

“because I can use it as an individual learning device, because I study better individually”.

The importance of user education

To take advantage of independent and autonomous use of devices, students have to feel confident and skilled in operating them.

After an initial introduction to the device, its operation, applications and functions, the assumption has been that learners, as ‘digital natives’, will explore the devices, play with them, learn what they are capable of and how to use them effectively.

Some learners do become expert users, constantly proactive in seeking out technicians, teachers and any other contacts to find out more. For example, some learners reported downloading items to the device – the list reported by some learners suggests that a subset of students (primary and secondary) have some level of technological know-how and are proactive in interacting with the device. The items downloaded include programs, sound files and applications for image management, peer-to-peer file sharing, task management, program launching and so on. These students often become a source of information for teachers and other students. However, their expertise can be flawed and their actions not always what the school wants or needs. There is a tension between the aspirations and expectations of the expert user and the school's need to control what programs are downloaded and what upgrades are made to the software.

The data also suggest, however, that many users are far from expert and are not equipped or motivated to become more expert. Evidence shows learners who do not feel confident about using the device and do not know how to improve:

“Haven't really been taught how to use them.”

“(The worst thing is) not knowing how to use the PDA.”

After a while, it becomes difficult for students to acknowledge a lack of skill, and the data suggest that lack of skill can lead to avoidance of device use or dependence on other more expert users – a frequent strategy, with users exhibiting all the signs of learned helplessness. By relying on others, these learners manage in class without having to develop their skills, but when most demands for use are for independent work out of school, they are unable to cope: without support networks, they cannot effectively use the device as a learning tool. The importance to users of help from family and friends is clear in the data.

Table 13 shows learners' reported sources of help.

Table 13: Sources of help in learning to use the device

	My family help me with the device %	My friends help me with the device %
Primary A	47	76
Primary B	17	77
Primary C	50	69
Secondary D	34	77
Secondary E	85	87

When we look at what high, medium and low users across Year 6 said about getting help from family or friends, the relationship between levels of use and a supportive context becomes more clear (see Table 14).

Table 14: Sources of help in relation to levels of use as reported by Year 6 pupils

Usage	Strongly agree/agree		Strongly disagree/disagree	
	Family help %	Friends help %	Family help %	Friends help %
High	62	83	26	10
Medium	45	69	25	16
Low	0	60	55	25

Many high users reported being helped by family and friends. The figures suggest that some users who perceive very low levels of support from any source are then likely to be low users. Support from friends assumes particular importance.

There is evidence in the data of groups in all schools where peer help and support are available. The transfer of knowledge is always represented as reciprocal, but, usually, there is at least one expert enthusiast in the group. Frequently, these experts have family members or contacts who are also knowledgeable and enthusiastic. The presence of high-frequency users in a peer group can determine a student's level of use. Where there are no skilled users in a peer group, the frequency of use is more likely to be low.

At present, peer support groups are based around friendships, although some learners referred to asking 'everyone in my class'. In the most close-knit groups, there are indications of overlap between learning to use the device and learning concepts and other skills – academic and social.

User education in all the schools is generally left to chance, although evidence from learners suggests that it needs to be ongoing and planned or facilitated. The challenge is to create conditions in which students can continue to develop their skills and understanding and become more confident. How can the gap be managed between the confident explorers and the inexperienced low users who are in danger of becoming demotivated? This question is salient to maximising independent use and to the successful integration of devices into class-based learning and teaching. Without the necessary skills, students are also more likely to exhibit what one teacher called 'the faff factor', delaying the progress of learning and frustrating the efforts of teachers to enact planned learning with devices.

Pupils' perspective on device use in specific areas

As we have reported, a large majority of students are positive about devices in relation to their learning. Only a very small number of students have a negative view of the device. However, the responses to some questions indicate some hesitation and uncertainty.

There was a high level of agreement that devices make learning more enjoyable, but, when asked whether they enjoy using their devices, more students were unsure. The relatively high percentage of 'unsure' responses to this and other questions signals perhaps a degree of uncertainty around some aspects of device use. Although the students were generally well-disposed towards having and using a mobile device, and felt positive about its impact and potential, some of their recounted experiences indicated ambivalence, which was also evident in their open-ended responses. Learners' ambivalence may be associated with relatively low levels of confidence in being able to use the device or fully exploit its potential, and, equally, a concern, also felt by teachers, that device use is not a tried and tested route to success at high-risk assessment points like Key Stage 2 SATs and GCSE.

Students were asked about writing on the device versus writing on paper, using the device to practise maths, and using the device to revise. Below, we also report students' views on the two dominant teacher-required uses for the device: searching the internet and making presentations.

Writing on the device and writing on paper

Table 15: Students' views about writing using the device

	I prefer to use paper and pen for my work rather than a mobile device %			I write more when I use the device %		
	Agree	Unsure	Disagree	Agree	Unsure	Disagree
Primary school A	24	29	47	56	6	38
Primary school B	33	33	28	44	33	23
Primary school C	13	33	54	40	35	25
Secondary School D Year 10	19	36	42	47	21	32
Secondary School E Year 7	17	18	65	56	19	25

In three schools, the numbers of students who agreed that they prefer writing with pen and paper are quite small (see Table 15); however, the figures show a degree of disagreement and uncertainty in each setting. We explored at interview and through classroom observation the issue of handwriting versus typing.

Those in favour of device use referred to: things looking better or neater when produced on screen; the possibility of using features of a program to engage in

graphic design; the availability of spell check and predictive text; the device being less likely to get lost than paper; their handwriting being bad; being good at typing; the keyboard being easy to use; using the device being easier than handwriting – doesn't hurt.

Those unsure or in favour of pen and paper referred to: electronic files being more likely than paper to get lost (deleted); the need to practise and improve handwriting; liking (or being more used to) using a pen or pencil to think and plan; being slow at typing; the keyboard being too small. Primary and secondary students were very aware that in tests or examinations they would need to write by hand, and primary students knew that their handwriting would be assessed.

In some cases, learners' ambivalence reflected concerns expressed by parents and teachers.

Practising maths and revising using the device

Table 16: Students' views about practising maths and revising using the device

	Practising maths on the device has helped me in the tests or exams %			Revising on the device has helped me in the tests or exams %		
	Agree	Unsure	Disagree	Agree	Unsure	Disagree
Primary school A	65	26	9	47	38	15
Primary school B	38	28	34	50	22	28
Primary school C	89	9	2	84	16	0
Secondary School D Year 10	19	38	43	49	35	16
Secondary School E Year 7	37	37	25	50	19	31

In each school, almost half the students who responded thought that revising using the device has helped them in the tests or examinations (see Table 16). Few disagreed, though some were unsure.

Revision took various forms including using files downloaded from teachers' devices, accessing popular revision websites, reviewing work collected on the device, and making notes and summaries on the device. Students commented that any time, anywhere access and having everything in one place was especially useful when revising.

The primary schools made extensive use of learning games in which children could choose which aspect of maths they wanted to practise and at what level. A similar programme for secondary schools was not in widespread use in the two schools, so only some students had accessed it.

Researching on the internet and making presentations

The two main types of teacher-required use of the device that students reported were researching on the internet and making presentations. These activities were undertaken in most subjects where teachers made use of the device. Improved wireless access and/or the availability of 3G meant that internet searching was the most common use of the devices formally and informally.

There was general enthusiasm for using the internet, which was seen as easy and fun. Some students were specific about the learning benefits:

“... achieving better grades with web access”.

Students in general believed that finding information on the internet is easy and straightforward. They reported being asked to research, and they clearly enjoyed the activity:

“When you go on the internet, like on Wikipedia and other sites, you get more than you would out of a book.”

However, students did not report any training in how to search effectively, to question sources, to use discrimination or to combine and transform information. They did not report having feedback on the quality of what they produced with what they found.

Some students suggested that too much use was made of presentation software. Reservations were expressed by some about the default request for slide shows and presentations.

Assessment

The research identified assessment and the provision of feedback on digital work as a key area. We saw some development in this area, and the experiments by a few teachers in giving formative feedback in audio format or typed on files were received positively by students. (For a fuller consideration of assessment and mobile devices, see the full overview report of the project: *Researching mobile learning: Overview – September 2006 to September 2008.*)

Impact of device use on attainment

In looking for patterns that may suggest a positive association between device use and attainment, or, conversely, a detrimental effect of device use on attainment, we compared attainment levels in SATs at the end of Key Stage 2 with attainment as predicted in data provided to schools by the Fischer Family Trust. Overall, we found that actual achievement in Key Stage 2 tests cannot be mapped to use of devices. Some high-level users achieved beyond their predicted grades; others did not. Similarly, some low-level users exceeded their predicted grades and others did not.

All three primary schools had some element of mobility in their populations over the period of the research. In all, we identified 94 students – 37 boys and 57 girls – for whom we had comparative data. Of these, 89 had 24/7 access to a handheld device. Five had in-school-only access. The attainment of 58 students in the sample was the same as predicted in all three core subjects. Fifty-six students either exceeded a predicted level of attainment or failed to reach it. Among these were 82 examples of attainment that was different from that predicted. Twenty students had differences in two or more of the three subjects.

Exceeding predicted levels

Thirty-two students exceeded their predicted levels of attainment. They provided 47 examples of difference. Of these, a large majority (34 examples from 24 students) were of attainment at L5 when it was predicted at L4.

There were 12 examples of attainment at L4 when L3 was predicted. One student achieved L3 when L2 was predicted.

Achieving below predicted levels

Twenty-five students did not achieve their predicted level of attainment. They provided 35 examples of difference.

The majority of examples were from those who did not achieve L5 as predicted. Eighteen students provided 27 examples of this. There were eight examples of not achieving L4 as predicted.

Attainment matched to levels of use

Students were categorised as high, medium or low users, in and out of school, on the basis of self-report.

Table 17 shows the levels of use of devices of those students whose attainment exceeded that predicted.

Table 17: Levels of use of those whose attainment exceeded predicted levels

Levels of use	Numbers of students
High in and out of school	9
High in, medium out of school	10
Medium in, high out of school	5
Medium in and out of school	5
High in, no access out of school	3
Total	32

Table 18 shows the levels of use of devices of those students whose attainment did not meet predicted levels.

Table 18: Levels of use of those whose attainment did meet predicted levels

Levels of use	Numbers of students
High in and out of school	7
High in, medium out of school	4
High in, low out of school	1
Medium in, high out of school	2
Medium in, medium out of school	5
Medium in, low out of school	5
Low in and low out of school	1
Medium in, no access out of school	1
Total	26

There is some slight indication that exceeding predicted levels of attainment is associated with high or medium device use, and that achieving below predicted levels is associated with medium or low use. Twenty-two out of the 32 students (72 per cent) who exceeded predicted levels of attainment reported high levels of device

use in school. Twelve of the 26 students (46 per cent) who did not achieve predicted levels reported high levels of device use in school; the other 54 per cent reported medium levels of use in school. More than a quarter of this group reported low or no use at home; a third reported high levels of use at home.

The picture is not clear. For example, we can look at the attainment of four enthusiastic, skilled users from the same Year 6 class, all of whom reported high levels of use in and out of school. Three did not attain L5 as predicted in seven out of nine tests; one achieved L5 (not predicted) in two subjects. Four students who exceeded predictions in 11 overall results reported medium use out of school. One very enthusiastic user in class, who did not take the device home, achieved unpredicted L5 in two subjects.

The sample is small and a large number of alternative variables could account for these results – some known to the researchers and teachers. The SATs performance data cannot enable us to determine whether device use is helpful or detrimental in key stage tests. However, other qualitative data suggest that, for many individuals, device ownership and use can have an impact more generally on less easily measurable aspects of learning such as attitude, motivation and engagement.

Teachers as users

The experiences of learners in the primary and secondary phases are in many ways strikingly similar. What, of course, is different is the number of teachers that learners encounter, each of whom will have a different attitude to incorporating device use in teaching and learning. These different attitudes contribute greatly to the amount of students' in-class use of devices and account for the considerable variation in levels of use they reported for learning in and out of school.

In general, the Year 6 teachers, with some individual variation, made regular use of devices or at least encouraged students to make regular use of them. The differences between high, medium and low users in the primary phase were created by the amount of out-of-school rather than in-school use they reported. Teachers were, however, clear in explaining that their first priority was preparing the children for assessments at the end of Key Stage 2, and that work on paper had higher priority than work done on the device.

The data from students in the secondary phase show that they would like more teachers to make use of devices in lessons and are frustrated by the negative attitudes of some. Year 11 students who determinedly continued to use the devices that they received in autumn 2006 said:

“The teachers don't have a clue how to work them, so they don't set any tasks on them and never suggest it [using them].”

“It makes learning much more fun and it's a brilliant piece of kit to have.”

“These devices really help with individual learning.”

The sense of missed opportunities or at least unexplored possibilities was evident in the responses from these and other students, including those who had stopped (or never really started) to use their devices:

“[the worst thing was] learning that their point has been wasted and teachers do not have the confidence in the device to use it as a learning object.”

“... lessons are not planned with them in mind; it’s not our fault, it is teacher’s.”

“It could help if used properly if used in class – then it could help learning – but it won’t help if it doesn’t get used.”

“If they could be used in a learning and confident environment, I believe they have potential – it’s just a shame I did not experience it.”

Explanations for the variation in teachers’ use of devices are in two respects very similar to those for students: lack of confidence and skill in using the device, and technical problems which make using the device for learning and teaching unreliable. Additionally, for teachers, device use is risky in that it can both increase demands on class management and require an act of faith that a new pedagogic approach will deliver outcomes at least as good as tried and tested models.

It is interesting that, when asked to nominate their worst learning experiences involving the device, many students gave accounts that reflect the frustration felt by teachers. This frustration appears to have been instrumental in causing the decline in use of devices after initial enthusiasm, or at least a reluctance to experiment:

“When the BBC website didn’t work, so we wasted a lesson trying to use it.”

“The PDAs are slow and a waste of my learning time. Moreover they don’t help me with my handwriting, do they!”

Students showed considerable empathy with their teachers and suggested some reasons for teachers’ reluctance:

- Teachers’ lack of skill with and understanding of PDAs and what they can do; students thought that teachers need more training
- Technical problems in class, for example failure to connect to the internet, and slow speed of the internet, both of which waste valuable class time
- Teachers’ fear that work on the PDA may be lost
- Teachers’ reluctance to deal with giving feedback on work produced digitally
- Problems in class with students who misuse their devices, for example by connecting to the internet, playing games and connecting to instant messaging applications.

These are all issues identified in teachers' interviews and commentary. Indeed, technical challenges such as ensuring that a whole class can be connected at the same time were present in all the schools in the project. Such challenges have limited the amount of use made of, for example, whole-class monitoring and interactive programs which, in principle, are designed to create teaching and learning opportunities.

Models of professional development

Secondary

In the secondary pilot project, all teachers were given devices in return for six hours' training. It quickly became clear that this approach was insufficient to ensure widespread take-up and effective use.

One subject group was identified to receive support from the project team in relation to resource provision and effective integration of devices in teaching and learning. The teachers involved, however, had too many other demands and priorities to adequately engage with a new challenge. In addition, there was insufficient consultation with teachers to ensure commitment to the project.

With the launch of a new project with a new device in autumn 2007, there were constraints on the number of devices that the project could fund for teachers. As a result, the innovation was targeted on specific curriculum areas and groups of teachers.

Secondary School D elected to continue with devices for Year 10/11 and to focus development on the English department. (During the pilot project, a successful use of devices by one English teacher – a strategy for developing speaking and listening – had been captured on video by our research. This successful strategy was used to exemplify device potential at a meeting of English teachers and welcomed by a member of the English strategy group in the south-west. The head of department at Secondary School D was subsequently persuaded to take up the challenge; he did this on the understanding that the focus was not the device or use of technology but the teaching and learning of English. From the start, there was a strong sense of ownership of the initiative within the school.)

Two members of the CLC project team – one technician and one English specialist – were allocated a day and a half each week to work in Secondary School D alongside the English teachers and the students, in particular with the head of department to lead the development. Among other things, the two team members developed a six-week module of work and saved everything the students needed (including videos and e-books) in one file to be downloaded onto the devices in advance of the lessons. Other modules followed.

The launch of the devices to the students in Secondary School D was controlled: devices were kept in school to be used exclusively in English lessons while students

were given basic training. The technician helped in lessons with training and troubleshooting technical problems. As teachers and students gained confidence and technical glitches were dealt with, the technician spent less time in lessons but was also available for students to consult individually at specific times during the week.

The head of department, English specialist and technician continued to work together to develop an application which was designed to serve a particular purpose in School D, identified by the teachers – it enabled teachers to increase participation in whole-class sessions, and enabled students' contributions to be captured and engaged with in whole-class interactions. The outcomes of the whole process could be saved and distributed.

A similar model of professional development and support to that in Secondary School D was in place in Secondary School E for Year 7 teachers and students in the Building Learning Power programme. Similarly there was a significant sense of ownership of the project by the school.

There was no expectation that teachers outside the focus department or course would incorporate devices in their teaching, although it was hoped they would support students who chose to use their devices.

In one school, a small number of loan devices were available for individuals or groups of teachers who wanted to experiment. Teachers in PSHE drew on these and developed a Year 10 work experience module, which was very well received by students. Information about these successes was disseminated in very brief staff sessions. There is some evidence that this had a 'viral' effect on some other teachers. Students reported that some teachers who did not have devices had designed some interesting work with them.

Even given this level of in-school support, the initiative, which is ongoing, has to be dealt with alongside all the other demands on teachers in both schools. The head of English, who is leading the development work in one school, reported that it is time-consuming and that, frustratingly, there is little time for reflection and dissemination. This feeling is echoed by others. Managing what is, potentially, a major innovation in teaching and learning across a whole year group of students and their teachers is very demanding for the lead teachers. Where the use of devices is an expression of whole-school policy, teachers need to see this in order to give it priority. Where devices are present in only one year group, it is understandably difficult to motivate teachers who have limited contact with students with devices. However, teachers of all device-equipped students need to be actively involved in the innovation for it to succeed. The option to ignore the devices or avoid the challenge by offering students choice should not be available.

Primary

The model of professional development in the primary project has taken a similar path to that in secondary schools.

The Learning2Go project had been garnering experience of handhelds in the primary phase for some years in advance of this research. The project identified particularly successful teachers, who shared their knowledge with newcomers. At the start of the research period, one teacher was seconded to work with the project team to provide continuing professional development (CPD).

In the early stages, teachers were taken out of school for training and development at the centre. As the project took on more schools, separate groups of new and experienced teachers were formed, with some sessions designed to bring the two groups together. After early sessions familiarising new users with the device, each session focused on using a specific application; examples were offered and teachers were able to practise. Time was also given for sharing successes, troubleshooting and raising issues. In all three research schools, teachers new to the project worked alongside or were supported by teachers who were already experienced with handheld devices in their classes. On a day-to-day basis, this was extremely valuable in building confidence and encouraging risk taking. Some in-school support was available from the project, but this focused more on technical issues (dominant in the early stages) than pedagogy.

As it became more difficult to ensure that teachers could come out of school to be trained, members of the support team went into schools to work alongside teachers. As with the secondary schools, this proved to be effective.

Overall

The research over two years demonstrates clearly that without professional development of teachers, the full potential of mobile devices as tools for learning will not be realised. The models developed by both projects place the focus of professional development on the processes of learning and teaching that exploit the potential of the device to achieve learning gains, and not simply on using the device for its own sake.

At this stage, teachers who have been closely involved with the mobile initiative, and project leaders and staff, think that dissemination of examples of good practice within their own schools, their local authority and beyond to others working with mobile devices is a logical and necessary next step. Time, it is thought, is also needed at this stage for teachers to reflect and consider the next steps in how best to develop the use of devices and what sort of support they need to achieve this. Teachers are not optimistic that support will be available: the support provided for teachers by Learning2Go and CLC3 may, the projects fear, be difficult to sustain at the current level when both projects expand. Disseminating what has been learned and facilitating teacher networks are therefore additional sources of professional development to add to the model.

Concluding remarks

We have documented, over the course of this study, the use of mobile devices in five schools. In the second interim report – *Researching mobile learning – second Interim report to Becta, April – December 2007* (McFarlane *et al.*, 2008) – we were able to report some very positive consolidation and developments in both primary and secondary phases. It was appropriate, in the final phase, to look more closely at device use by teachers and learners; this has given us a more fine-grained understanding of when devices are used, how often, for what purposes, and of the factors that have an impact on this. A final overview report, *Researching mobile learning: Overview – September 2006 to September 2008* (McFarlane & Triggs, 2009), published concurrently with this Phase 3 report, summarises the research findings overall and reflects on and discusses the outcomes.

We are fortunate in now being able to follow a large proportion of the learners we researched in Year 5 and 6 into their first year in secondary school. Most own their devices. Some are joining a school that is introducing mobile device use in Year 7; the others are joining schools that offer different forms of technological support for teaching and learning. We look forward to reporting on their progress and the ongoing story of their relationship with Mobile 1:1.

Appendix A

Research

The design of the research project was developmental in that data were progressively analysed and findings fed back regularly to teachers and headteachers for their validation and comment.

The researchers' role, initially, was to record and provide a mirror. As the project progressed, teachers, as co-researchers, were invited to make a contribution to the analysis of data and the creation of knowledge. The findings were shared with and validated by all involved.

The research fed into developments in implementation and practice. Findings were disseminated at seminars and conferences and through the publication of interim reports on the Becta website.

Research questions

We addressed the following questions:

- What pedagogic models best support effective use of one-to-one access to educational resources and tools via a mobile learning device?
- 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 affecting this kind of access and use, and how have they been met?

Schools

Three primary schools and two secondary schools were involved in the research. These schools joined the research at different times, and in the case of the secondary schools, the research focus was adjusted in the second year for reasons outlined below.

In all cases, the headteachers showed significant commitment to the vision of embedded use of technology in the school through the use of personal mobile devices.

Primary school A

Primary School A has, for the most part, one class in each year and an intake of nursery-age children. It is situated in an area with a good socio-economic demographic, although, because it is a Catholic school, some pupils are from outside the immediate neighbourhood of the school. Most pupils are from white British backgrounds, although a small number are from minority ethnic heritages. The proportion of pupils eligible for free school meals is half the national average. The proportion of pupils who have learning difficulties and disabilities is broadly average.

The school is e-mature (mature in its use of technology-enhanced learning) and has a clear vision for the development of technology-enhanced learning. The decision to join the Mobile 1:1 project with Year 5 classes was taken as a result of a previously successful pilot in Year 6. The headteacher and ICT co-ordinator gave the project their complete support.

Relationships with the parents and carers of the children are good. The school is trusted and valued. Attainment at the end of Year 6 was above the national average, with a third of the children achieving Level 5 in English and maths tests. Children with special learning needs obtained at least Level 3, except in maths, for which one child was not entered.

Primary School B

Primary School B is a Catholic school. The pupils are from a variety of social and economic backgrounds; most are of white British heritage and have English as their first language. The percentage of pupils with any kind of learning difficulty is a little below average. The school is small; pupils are taught in five classes and most classes include pupils from more than one year group.

The school is e-mature and, before the school joined the Mobile 1:1 project, already had a year's experience of using mobile devices in Year 4/5 and Year 5/6. The headteacher and deputy headteacher (and Year 5/6 teacher) were enthusiastic about the potential impact of devices on children's learning.

Primary School C

Primary School C is large, with two classes in each year and a nursery. It is situated in an area of socio-economic disadvantage; the percentage of pupils eligible for free school meals is more than double the national average. The pupils are from a diverse range of ethnic backgrounds. About a third are of white British backgrounds, and a large proportion of pupils from other ethnic backgrounds have English as an additional language. About a tenth of pupils are asylum seekers or refugees. There is a lot of movement of pupils in and out of the school in all years. The proportion of pupils with learning difficulties and/or disabilities is below average.

The school is e-mature; it engages in self-review and one teacher has actively and successfully led the development of e-learning throughout the school. Before the start of this project, the Year 6 teacher piloted the use of handheld devices; the enthusiasm generated by this led to the decision to launch a two-year Mobile 1:1 project with Year 5. This had the complete support of the school leadership and senior management team.

Links with the community are purposefully created, and the school has an excellent relationship with the parents and carers of the pupils. The school is trusted and valued.

Within the curriculum, the school places particular emphasis on the expressive arts and on the development of creativity. In general, children enter the nursery with attainment well below the level expected for their age and with little strength in communication skills. Attainment at the end of Year 6 is at or above the national average.

Secondary School D

Secondary School D has around 800 students, the majority of whom are of white British heritage and from predominantly deprived socio-economic backgrounds. The percentage of students eligible for free school meals and the number with learning difficulties and/or disabilities are double the national average.

The school moved into completely new buildings in September 2005 and is now a specialist arts college. It is seen as an improving school which is well led and managed, with a steadily rising intake in Year 7.

The school has been focusing with some success on raising attainment for all students. The decision to join the Mobile 1:1 initiative with Year 10 in 2006 was part of the raising attainment agenda but also inspired by a desire to engage students more in their own learning in and out of school. In 2008, in GCSE examinations, 39 per cent of students gained five or more A*–C grades overall. Twenty-five per cent of students gained five or more A*–C grades including maths and English. This was below the local authority and national average. Eighty-five per cent of students gained five or more A*–C grades.

Secondary School E

Secondary School E has specialist status for maths and computing, with around 780 students. It is one of two Catholic secondary schools in the local area and draws its students from a wide area in the city. Many students come from areas of socio-economic disadvantage; however the proportion eligible for free school meals is below average. Around 12 per cent of students have learning difficulties of some kind, a figure that is below the national average. Most pupils are white British.

Involvement with the Mobile 1:1 project in 2006 was inspired initially by the enthusiasm of senior teachers who were interested to explore the potential of the technology in learning.

In 2007 in GCSE examinations, 44 per cent of students gained five or more A*–C grades including English and maths; this was above the local authority average.

Sample

Table 19 shows which schools were involved in the project, and when.

Table 19: Timeline of the involvement of schools and year groups

2006–07			2007–08		
Autumn	Spring	Summer	Autumn	Spring	Summer
Primary A Year 5			Year 6		
	Primary B Year 5		Year 6		
		Primary C Year 5	Year 6		
Secondary D Year 10			Year 11		
Secondary E Year 10			Year 11		
			Secondary D Year 10		
			Secondary E Year 7		

The research was designed with a two-year longitudinal focus. Students in Years 5 and 10 at the start of the project in 2006 would be followed to a major external assessment point – Key Stage 2 SATs and GCSEs – in 2008.

The extension in Phase 2 of the sample size and focus of the research beyond these students was caused by changes to the secondary school project. (Reported in the Phase 2 report, *Researching mobile learning – Interim report to Becta, April – December 2007* (McFarlane et al., 2008).) In the summer term of 2007, in spite of an active response by the city learning centre to initial problems in implementation, it was clear that use of the devices by teachers in the secondary schools was not as wholehearted as had been hoped, and this was affecting students' in-school use. In addition there were concerns about the reliability, robustness and suitability of the device. The decision was taken to build on those positive aspects that had emerged and to re-launch the project with a new model of device. One school elected to re-

launch with Year 7 students, the other to begin again with Year 10. Year 11 students in both schools continued to own and be free to use the devices they acquired in September 2006.

Size of sample

- Primary A: 34 (two classes in Year 5; one class in Year 6)
- Primary B: 18 (mixed classes in Year 5 and Year 6)
- Primary C: 57 (two classes in Years 5 and 6)
- Secondary D: Year 10/11, 184/167 (2006–08)
- Secondary D: Year 10, 170 (2007–08)
- Secondary E: Year 10/11, 159/156 (2006–08)
- Secondary E: Year 7, 151 (2007–08)

Data sources

Phase 1: Autumn and spring terms 2006–07

The data collected included:

- a baseline survey on pupils' experiences of and access to technology in and out of school
- data on attainment, attendance and learner disposition
- interviews with head teachers, teachers and other key staff
- week-long pupil diaries, recording device use in and out of school (primary)
- day-long observations of groups of pupils supplemented by informal interviews.

Phase 2: Summer and autumn 2007

The data collected included:

- classroom observations and interviews with teachers and learners
- video recordings of device screens, captured as learners used and talked about their devices
- video recordings of learning and teaching episodes
- visits to CPD events.

Video recording in class occurred only when trust had been established between teachers and researchers.

Phase 3: Spring and summer 2008

The data collected included:

- surveys of use, administered to all sample groups in the spring

- follow-up interviews with a group of students in each school and year group in the summer; students were selected on the basis of reported frequency of use to explore further explanations of levels of high, medium and low use in and out of school
- video recordings of device screens as pupils reviewed device use
- interviews with teachers and project staff
- classroom observations of lessons and students
- data on attainment and attendance at the end of the key stage.