



Tablet PCs in schools Case study report

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Executive summary

This report provides an analysis of twelve case studies involving schools in England that were using Tablet PCs. The analysis is complemented by brief individual reports describing aspects of how each of these schools was using Tablet PCs.

Key findings

The key findings emerging from the case studies were that Tablet PCs:

- for maximum benefit, needed to be used in conjunction with a wireless network
- needed to be introduced in a planned way that took full account of the school's vision, as well as of the technical infrastructure, support and staff development, and day-to-day management issues
- increased the amount of ICT use and the degree of integration of ICT across the curriculum
- at some schools were used effectively to replace an ICT suite and thus free up space
- increased motivation, and hence were likely to have a positive impact on learning outcomes
- supported moves to more independent and collaborative study
- used with a wireless data projector, provided a better solution than a desktop or laptop and hardwired interactive whiteboard
- were seen as being more versatile than laptops, although the higher price of Tablet PCs relative to similarly specified laptops was prohibitive.

Summary of the case studies

Seven primary schools and five secondary schools (including one special school) were selected from over 90 schools in England that were identified as using Tablet PCs in late 2004. Data collection took place in December 2004 and early 2005.

Tablet PCs are a relatively new development, and none of the schools had been using them for more than two years. It seems likely that the practice documented here represents a period of transition during which schools were experimenting in order to find out how best to make full use of the potential offered by Tablet PCs.

Both slate and 'convertible' Tablet PCs were in use. The number of machines ranged from four to over 300. Schools varied as to whether they allocated Tablet PCs to staff or students, and whether the machines were shared between users or 'owned' by them. The resourcing levels that schools thought necessary for effective student use also varied considerably, in terms of both the number of Tablet PCs and also the amount of time that individual students needed to spend using a Tablet PC each week. These variations seemed to be closely linked with the school's vision for education.

'Ownership', the use of champions and having a critical mass of staff and/or student users all seemed to be important factors contributing to effective Tablet PC use.

It was clear that the increase in ICT skills related to the amount of Tablet PC use and that, with Tablet PCs, ICT was much more integrated with other subject teaching. A timetabled class set of Tablet PCs could effectively replace an ICT suite, freeing up space and enhancing the amount of ICT undertaken and the degree of integration of ICT in the curriculum.

To support and extend whole-class teaching, Tablet PCs were used with data projectors in conjunction with wireless internet access to widen the range of resources available to teachers and students.

In many schools there was a move towards cross-curricular working and/or a greater emphasis on 'independent research'.

All the schools found that Tablet PCs (when they worked) had a significant positive impact on motivation. All the schools felt that the Tablet PCs had enhanced learning, although the majority thought it was too soon to be able to see this in standard performance indicators. In some cases, introducing Tablet PCs had freed up other resources and extended learning beyond the confines of the school. Tablet PCs were seen as providing a particularly convenient interface between the physical spaces where staff and students were working and the school's 'virtual' resources.

Staff tended to use Tablet PCs in laptop mode, except for marking or when working with children. Students tended to use the pen, except for extended writing, when they tended to use a physical keyboard. When using the pen for writing, students tended to use the onscreen keyboard or to leave their writing as digital ink. Few of the schools used handwriting recognition. There is scope for schools to explore the potential of handwriting recognition further, particularly in the light of the enhancements in the 2005 edition of the Tablet PC operating system.

There was general agreement that wireless networking was essential for effective Tablet PC use. Two thirds of the schools thought that data projectors were also very important. There was general agreement that a Tablet PC plus data projector with wireless connection was better and more cost effective than an interactive whiteboard or a laptop plus data projector.

Tablet PCs were almost universally seen as being more versatile than laptops, but around a third of the schools considered the price differential prohibitive. There were also concerns about security issues, battery life, screen size and glare, and the cost of replacing pens.

There was general agreement that the introduction of Tablet PCs required careful planning and extra (on-site) support. Where users were already confident with ICT they adapted easily to using Tablet PCs, which most people found to be very natural and intuitive.

Much of the work observed could, in the researchers' view, have been achieved using a laptop. However, schools often did not share this view. There was a general consensus that Tablet PCs (in slate mode) were qualitatively different from laptops or other computers and that students related to them more intimately.

There is significant scope for further evaluation of the potential of Tablet PCs to enhance learning and teaching.

"Despite problems we are still optimistic that we will recoup on what has been a big investment –there is no going back – they are so much more mobile and the children really like them ... It is always difficult to be a 'lead school' but we knew this and accepted it. We are still convinced that this is a better solution than laptops or an ICT suite but you need to stand by your beliefs and to persevere especially if there are unexpected problems."

Senior management team, St Peter's



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What is a Tablet PC?

A Tablet PC is a lightweight computer, similar to a notebook, which allows the user to interact with software using a stylus (digitiser pen) as if writing on a slate.

'Microsoft and a number of hardware manufacturers (including Acer, Toshiba, Hewlett-Packard, Fujitsu Siemens and RM) launched the Tablet PC in November 2002.

The Tablet PC is a fully functional Windows XP portable computer that can be operated with a digital pen. The pen can be used to control the PC and also to 'write' on the screen of the device. Integrated handwriting recognition technology enables users to create handwritten documents. Handwriting can be saved as an image, converted into typed text, and some applications, such as Windows Journal, allow the user to save and search 'digital ink' documents. Tablet PCs offer an alternative to pen and paper, with a more natural and intuitive interface than a conventional laptop computer. Tablets can also be easily carried around providing enhanced mobility and ease of use.' (Becta 2004, p1)

There are two basic types of Tablet PC:

- 'slates', which lack keyboards, although they can be connected to a USB keyboard or docking station
- 'convertibles', which come with an attached keyboard and can be used in either slate or laptop mode.

The case study index grid on p24 provides an overview of the numbers and types of Tablet PC used in the case study schools.

Tablet PCs typically do not have internal floppy, CD or DVD drives or 'legacy ports' (such as serial ports). This applied to all of the Tablet PCs in use in the case study schools, although many of the schools had a small number of external drives and/or port adaptors for use with their Tablet PCs.

Two versions of the Tablet PC operating system are available, and were in use in the case study schools:

- the original Windows XP Tablet PC operating system (which we refer to as 'the original Tablet operating system' throughout this report), which is the same as Windows XP with the addition of functionality to support pen input

- Windows XP Tablet PC Edition 2005 – an enhanced version of the operating system, released in August 2004 (which we refer to as 'Tablet 2005').

Both versions of the Tablet PC operating system provide handwriting recognition and are supplied with Journal and StickyNotes, which are note-taking applications that take advantage of pen input. However, Tablet 2005 provides enhanced handwriting-recognition features including:

- more accurate word and character recognition
- an improved input panel, instantly accessible in all applications, that provides 'real time' conversion, more input modes (such as 'free text' and individual characters), and improved facilities for correcting mistakes in the conversion from handwriting to text
- handwritten annotation facilities that integrate with Office 2003.

Seven of the case study schools were using the original Tablet operating system; three were using Tablet 2005; two were using a mixture of the two on different machines.

Example of original Tablet PC operating system input panel



Examples of Tablet 2005 input panel and handwriting-recognition correction facility



Analysis

This report is based on 12 case studies carried out between the beginning of December 2004 and early February 2005. The case studies set out to address a number of key questions identified by the literature and projects review that was carried out by the team in late 2004 (see Sheehy *et al* 2005).

Each case study involved the same basic design, which included:

- a questionnaire completed by the ICT co-ordinator and followed by an interview
- an interview with a member of the senior management team (SMT)
- separate observations of two key users, who were then interviewed
- portfolios illustrating how Tablet PCs were used, compiled by the two key users
- logs of Tablet PC use over a two-week period, compiled by the two key users
- further interviews with the two key users to follow up on the portfolios and usage logs.

In practice, there were inevitably minor variations to the data collection across the case studies to take into account the local context. In all cases the data collection allowed the same set of key questions to be addressed.

It is worth highlighting a number of factors to bear in mind when reading this report.

Firstly, the longest that any of the schools had owned Tablet PCs was two years. One school had received all of its Tablet PCs only a matter of weeks before the data collection took place, though the school had been planning and trialling their implementation for considerably longer. Many of the schools felt that they had not had enough time to experiment with their Tablet PCs and were still exploring how to use them most effectively. It may well be that the practice documented here represents a period of transition from the use of traditional desktop and/or laptop PCs to the exploitation of the full potential offered by Tablet PCs.

Secondly, in around half of the case studies the introduction of Tablet PCs was accompanied by the simultaneous introduction of wireless networking and/or servers. The extent to which any issues or changes were due to the Tablet PCs, to the other changes in ICT infrastructure and/or to an interaction between the various systems was therefore not always clear.

Thirdly, in all the case studies the introduction of the Tablet PCs meant an increase in the level of ICT provision. Furthermore, their introduction often represented a school's first move into using mobile technologies. Thus, many of the issues and changes identified in the data may be due to an increase in the overall level of ICT use and/or in the provision of mobile technologies in general rather than to Tablet PCs specifically.

'Even though we've had the Tablets for two years we are still learning and experimenting with them; there's very little guidance out there on the best way to use them.'

Field notes, Queensbury

'As the initial level of ICT skills for some staff was very low, their first step was to engage them through administration, planning and a limited range of teaching activities. This has proved very successful and they are now extending all aspects of Tablet PC use to take full advantage of their potential. We'd need to wait a year I think to see the real impact of this.'

Field notes, Wilmslow

"People want to do more things now: we are getting to the stage where children can access material from central resources on the server... getting this in place takes time."

Teacher, St Peter's

Descriptions of practice

The case study overviews (pp24–51) provide a rich picture of different ways in which Tablet PCs were used in the 12 case study schools. The case study index grid on p24 gives an overview of some of the key differences between the schools. In this section we highlight a number of different dimensions that were evident in the case study schools.

Tablet PCs are typically described as either slates or convertibles. Convertibles include an integral keyboard which you twist to convert the Tablet PC into slate mode, and which in some cases you can totally remove. Four of the case study schools used convertible-style Tablet PCs. The remaining eight provided slate-style Tablet PCs for their students. Two of the secondary schools in this latter group also provided convertible-style Tablet PCs for their staff. Where slate-style Tablet PCs were used, external keyboards and/or docking stations were sometimes also available.

The number of Tablet PCs in each of the case study schools varied from 4 to over 300. The way in which Tablet PCs were organised varied across two key dimensions: to whom they were allocated; and whether they were shared or 'owned'. There was no clear pattern to the way in which the Tablet PCs were organised based on the number of machines available.

In two cases where there were only a few Tablet PCs, one or more of these was allocated to an individual child on a long-term basis, as part of support for a particular learning difficulty. Half the case study schools kept at least some of their Tablet PCs as sets, often on mobile charging trolleys, which were then timetabled for use by specific classes and/or were bookable. These sets varied in size from 4 to 30 machines, with 14 or 15 being the most common (three cases). In one secondary school, Tablet PCs (with associated data-projection equipment) were allocated to specific classrooms. In another secondary school, Tablet PCs (with associated data-projection equipment) were allocated to all staff in one department. In a third secondary school, class sets were allocated to specific subject areas. Two secondary schools and one primary school allocated each child in one or more classes their own Tablet PC for a prolonged period (at least one year). In these latter cases, teachers were also allocated their own Tablet PCs. This either meant one teacher (in the primary school this was the class teacher, who also had her own laptop) or most teachers in the school (in both secondary schools). In another primary school most of the staff were provided with a Tablet PC as their main computer. Most of the schools used their Tablet PCs with data projectors.

“Staff are making more effective use of electronic resources for planning and delivery of lessons. They are using the network to transfer files and use the Tablets to record notes at staff meetings, thus reducing the amount of paper produced and carried.”

ICT consultant, Engayne

Tablet PCs were being organised and managed in many different ways, which depended more on the 'vision' underpinning their use rather than on the number of machines available.

Where staff had ownership of a Tablet PC they were using them for administration, preparation, teaching and their own professional development. Staff use often involved whole-class teaching, using the Tablet PC in conjunction with a data projector.

Where students had ownership of a Tablet PC the Tablet PCs were in use for more of the time than when Tablet PCs were shared between classes. Students quickly learned how to operate the features specific to the Tablet PC, building upon their existing ICT skills.

Advantages of ownership

Where staff and students 'owned' Tablet PCs, there seemed to be clear evidence that the impact was greater than when the equipment was being shared. This seems to have related to both the actual amount of time that was available for experimenting with the Tablet PCs and also the 'convenience' factor. Where staff were not allocated their own Tablet PC, they often had ownership of either a laptop or a PC at home, and this reduced their use of a shared staff Tablet PC. Where students were sharing a Tablet PC, the amount of time they spent using it was significantly less (often around 10% of the available time) than in those cases where the students 'owned' a Tablet PC (where estimates of use varied from 25% to 75% of the available time). It appeared that in most of the schools where the Tablet PCs were shared, these were not in use for much of the time, either because they had not been booked or because significant sections of the lessons where they were scheduled to be used involved whole-class teaching. In one observation of a literacy lesson, for example, the Tablet PCs were used for less than a third of the lesson time – and much of that use involved switching them on and locating the materials that the children were supposed to be using. In contrast, in two schools where children owned their Tablet PCs they used them for taking handwritten notes during whole-class sessions. This apparent difference may have been due to a range of factors, including the phase of education, but ownership of the Tablet PCs did seem to be important in that it increased familiarity and confidence, and children did not have to worry about printing out their notes or saving them to a network in order to retain them.

Why did schools buy Tablet PCs?

Five of the case study schools indicated that they had obtained Tablet PCs as part of a project that they were involved in. The remaining schools highlighted specific features of Tablet PCs which had led them to invest in them. The most commonly mentioned feature of Tablet PCs was their mobility (four cases), which was seen as being greater than that of a laptop. Another school specifically mentioned the need to save space by replacing their ICT suite with Tablet PCs. Two schools chose Tablet PCs because they represented the cutting edge of PC technology and the schools were keen to buy equipment that would not become obsolete too rapidly. Two schools mentioned the potential that they saw in the Tablet PC's pen interface.

What surprises did they have on introducing Tablet PCs?

The practical issues of introducing Tablet PCs surprised most of the schools. In some cases there were considerable technical problems, though these may often have been to do with the simultaneous introduction of new servers and/or wireless networking.

All the schools where pupils had ownership of the Tablet PCs commented on the children's ability to come to grips with them, in terms of the speed with which they learned to use them and/or the imaginative ways in which they were using them. Even where the Tablet PCs were shared, there was considerable agreement that the children (and staff) learned to use them quickly, building upon their existing ICT skills.

Many of the schools commented that they were now teaching ICT skills in context rather than as discrete ICT lessons, and that the general level of ICT competence had increased. However, nearly all the schools indicated that they needed more time to find out how to take full advantage of Tablet PCs.

All the schools seemed to be enthusiastic about increasing the use of Tablet PCs in the future, though several were uncertain whether they could justify the additional cost of Tablet PCs compared with laptops of similar specification.

"Tablet PCs had enough of a future model about them but were not too far ahead, remaining compatible with the existing ICT knowledge of staff and pupils ... Laptops are dominated by keyboard-using skills and the stylus input of the Tablet PCs offered more intuitive potential."

SMT, Engayne



Impact – staff

We explored the extent to which staff were using Tablet PCs for management (strategic planning and performance management, for instance), administration (such as registration), planning, preparation, teaching, marking, record keeping, communication (with colleagues, students or parents) or in other ways.

Of the five schools in which staff had ownership of Tablet PCs, four used their Tablet PCs for most aspects of their work. In at least one case this included taking handwritten notes in staff meetings, as well as other administrative tasks. The staff in one of these four schools did not use their Tablet PCs for marking. In the fifth 'staff ownership' school the teacher also had her own laptop, which she tended to use instead of her Tablet PC, except for marking which she did on the Tablet PC. Communication via ICT with parents was uncommon in all the case study schools.

Where staff did not have ownership of a Tablet PC, they tended to have ownership of a laptop, which they used for most aspects of their work. In these cases, Tablet PC use was limited to preparation and teaching (which often included marking work on the children's Tablet PCs). Preparation often only meant initial familiarisation with the Tablet PC and copying resources from their own computer (using a memory stick or over the local area network, for instance) onto the Tablet PC for use in the lesson. In a number of schools the Tablet PCs were configured so that they worked with the school network but could not be used at home, which staff commented on as being a

"I feel more professional. I'm not only improving my knowledge but going into class with PowerPoint presentations. It [the Tablet PC] adds quality and can make me more efficient."

Teacher, Wilmslow

problem. Where this was the case, teachers tended to prepare their lessons on another computer or, in one case, on the Tablet PC in school during planning, preparation and assessment time.

Using the Tablet PC for teaching either meant supporting the children's use of the Tablet PCs and/or using a Tablet PC with a data projector (for more on this, see **6 – Complementary technologies**, p13). Many of the schools indicated that using Tablet PCs in their teaching had had an impact on their pedagogy, resulting in more independent work, often based around research using the internet (see also **3 – Impact – curriculum**, p6).

Where staff were using the Tablet PCs extensively, they often reported that their own ICT skills had increased considerably. However, in at least one case this was clearly more to do with the amount of time they were spending using ICT than the fact that they were using Tablet PCs *per se*. Indeed it was predominantly the case that staff reported using Tablet PCs outside class time as if they were laptops, except when marking children's work (when they tended to use handwritten annotations).

"Tablets have renewed my enthusiasm for topics – they offer new exciting approaches. I have begun to consider Tablets as a matter of course when lesson planning. They offer another dimension which embraces different learning styles."

Deputy Head, St Mary's

Staff ownership seemed to be a very important determinant of the level of impact that Tablet PCs had on staff usage. Where staff were making more extensive use of Tablet PCs – even where this was limited to teaching time – their ICT confidence and competence increased.

All the case study schools reported using the Tablet PCs for teaching, which often meant using them in conjunction with a data projector. Where sets of Tablet PCs were available for student use, teachers often noted planning for their use, though this normally did not involve the teacher in using a Tablet PC as part of the planning or preparation process (except where the teacher had ownership of a Tablet PC).

Impact – curriculum

We examined the impact of Tablet PCs on the curriculum (what was ‘taught’ and how it was ‘taught’) using part of the Computer Practice Framework (Twining 2002), which identifies three different possible levels of impact:

- Support – increasing efficiency without changing the curriculum
- Extend – the curriculum is changed, but this could have been achieved without Tablet PCs
- Transform – the curriculum is changed, and this could not have been achieved without Tablet PCs.

Support and Extend

The field researchers noted that most of the work that they observed or had described to them could, in their view, have been achieved using standard laptops. It was often the case that the same software was used on the Tablet PCs as on other computers in the school. Unpacking the relative importance of Tablet PCs compared with other aspects of a school’s ICT infrastructure – or indeed compared with the results that might have been achieved using a similar number of laptops – is difficult, if not impossible. It may also be unhelpful, as it is likely that the impacts on the curriculum that were identified are the result of a combination of factors, with the Tablet PCs being part of the whole. There may also be ‘subtle features’ of Tablet PCs which have a significant impact (see also 5 – **Features of Tablet PCs**, p10). What is clear is that the Tablet PCs were felt by all the case study schools to be having a positive impact on the curriculum.

There were many examples of using the Tablet PC – often in conjunction with a data projector – to support and extend whole-class teaching (see also 6 – **Complementary technologies**, p13).

The technology increased the pace of such lessons and the quality of the content being examined, but often without any impact on the subject matter being studied. When used in conjunction with the internet, Tablet PCs clearly extended the range of resources that students and teachers had access to. A Tablet PC plus local area network and internet access were

‘Their size and portability means they can be used by the whole class in a normal classroom, and this means they can support and extend teaching and learning anywhere.’

Field notes, Wylde Green

“The pen technology allows for very direct cursor use with direct hand/eye co-ordination and doesn’t rely on a remote cursor/eye co-ordination. This must have an impact on the way in which the pupils remember what they are writing/doing.”

Project co-ordinator, Cornwallis

reported in several cases as altering the dynamic of a session, making it more flexible, spontaneous and at times opportunistic. For example, it enabled staff and students to refer back to previous lessons and/or to save multiple versions of their work so that they could examine how it had changed over time.

Tablet PCs were being used in ways that supported, extended and transformed the curriculum. The pace of lessons was improved, as was the richness and variety of the content examined.

In most schools, Tablet PC use led to more cross-curricular work, in terms of integrating ICT in other subjects and/or moving to more multi-disciplinary or ‘topic’ types of activity, that often involved more ‘independent’ research and collaborative work.

In a smaller number of cases, Tablet PCs were seen as transforming the curriculum, particularly where students had ownership of the technology, or where Tablet PCs were being used to extend learning outside the formal classroom context.

Many people regarded the pen as a more intuitive and direct physical interface with the PC compared with a mouse and keyboard (or touch-pad on a laptop). This was seen as making certain software more accessible, particularly where it involved selecting moving items on the screen. One specific example of this was using Wordshark, which the children found almost impossible with a standard laptop touch-pad, yet very easy with the Tablet PC pen.

Several schools commented on how the Tablet PCs had changed what the children were learning, though this often appeared to have more to do with the fact that they were using new software than that they were using Tablet PCs. For example, one school used KarZouche for the first time on Tablet PCs and felt that this had significantly altered the nature and content of the sessions.

One field researcher described how the Tablet PCs appeared to have 'revitalised the teachers', increasing their motivation in general and their enthusiasm for integrating ICT into the curriculum in particular. Many of the schools commented on the way in which the teaching of ICT had become an integral part of their teaching, in one case 'doing away with the need for discrete ICT lessons'.

In four of the six primary schools, the teachers reported that using the Tablet PCs had led to a move back towards cross-curricular work, which in at least one case was accompanied by a loosening of the timetable and a move away from the constraints of the literacy and numeracy hours. There was evidence in many of the schools of a greater emphasis on 'independent research' and on collaborative work, with children asking questions, locating information, evaluating that information and then re-presenting it in different ways (often using multimedia).

Transform

The use of the pen input, which is a key feature of Tablet PCs, often indicated when a change was transformational (that is, making changes that could not have been achieved without Tablet PCs). Examples of this included:

- one child who had poor motor control was able to use the handwriting-recognition facility of the Tablet PC to record her work, thus providing her with access to the curriculum from which she would otherwise have been excluded
- art work in several schools, where the use of the pen was clearly seen as changing the dynamic and providing a qualitatively different experience, even when using 'standard' painting and drawing packages
- in several of the case study schools, adding handwritten notes to work in Journal or OneNote and using Tablet 2005's annotation facility in Office 2003 appeared to change qualitatively both the process of note taking in class and the process of marking work
- in one school the children created animations to illustrate and explain scientific process in a way that the field researcher felt they would not have been able to do using a standard laptop or PC.

One field researcher described the way in which the children's own Tablet PCs were used in conjunction with a data projector to develop 'corporate note taking': children's individual notes were shared by connecting their Tablet PC to the data projector, in order to move towards a record that represented a class consensus.

In another school, the use of the Tablet PC had extended outside the classroom and was seen as changing the nature of field trips. In yet another, the mobility of the Tablet PCs had also helped to transform aspects of the PE curriculum, changing the way that teachers and pupils interacted with data and allowing sports analysis to be integrated into practical sessions rather than being restricted to formal classroom lessons.

"For some teachers it has been transformational. For some students, it has completely changed the way they do things. Others find the technological challenges more difficult and therefore I would say it hinders their learning."

Deputy Head, Invicta

Impact – students

We explored which students were using Tablet PCs, when and where they used them and what impact, if any, the Tablet PCs were having on students' learning (including motivation, access to the curriculum, learning outcomes, learning approaches and so on).

Which students were using the Tablet PCs and where did they use them?

In two of the secondary schools where one Tablet PC was allocated to the classroom or teacher, direct student use of the Tablet PCs was quite limited. In one case the Tablet PC was sometimes passed around during whole-class presentations (using wireless data projection). In the other school, students entered and analysed data (including video) on their own performance as part of a circuit of activities.

In one school, where some Tablet PCs had been allocated to specific individuals as part of their SEN provision, those children used the Tablet PCs across all of their lessons and at home. This model of use was also in evidence in the two secondary schools where all the children in a class or year group had their own Tablet PC. Many of the children (around 80% in one of these schools) chose not to take their Tablet PC home regularly. The other school in which all of one class had their own Tablet PC (a primary school) did not allow the children to take them home. In contrast to this, one school had allocated most of its Tablet PCs to targeted individuals as part of a literacy project for half a term, and these children had kept their Tablet PCs at home, only bringing them in to school once or twice a week.

Children who shared access to the Tablet PCs used them for some lessons, often on a regular timetabled basis. This applied to one secondary school and six primary schools. In one of these primary schools, the Tablet PCs tended to be used by children who were withdrawn from the classroom for additional support and/or extension activities.

In most of the case study schools the Tablet PCs were used across all subject areas, though different year groups often used them for different subjects. In the primary schools this was often as part of a cross-curricular research activity. Two schools specifically used the Tablet PCs to teach ICT, though one of these schools integrated this with maths, science and literacy work. Another primary school specifically said that they did not use the Tablet PCs to teach discrete ICT, preferring to integrate it across the curriculum.

It was clear both from the interviews and observations in all of the schools that using the Tablet PCs had a substantial impact on students' motivation. Two of the schools commented that motivation increased when the technology worked, but could decrease when the technology did not work. All the other schools were very clear about the positive impact of the Tablet PCs on motivation. One school noted a drop in absences on the days when the Tablets were due to be used. Four schools also noted that the children's concentration and time on task increased when using the Tablet PCs. Two other schools noted that the children's behaviour improved when the Tablet PCs were available. One school explicitly stated that the level of motivation was greater than that when using laptops.

“Discrete ICT is becoming a thing of the past, as staff begin to realise the importance of embedding ICT skills into other areas of the curriculum. Spreadsheets are used to support the teaching of maths, science, history, geography etc – not as cold, standalone spreadsheet activities that bear no link to real-life application.”

ICT consultant, Engayne

‘It’s early days and it remains to be seen what impact they will have on progress – there is an impact on motivation and if they are motivated and enjoying learning then there is a higher chance that it will affect attainment and progress.’

Field notes, St Peter’s

“What happens in the different locations has become less rigid. The Tablets have enabled a more varied programme, so boredom-related behavioural problems are lessening. Performance/achievements may be increasing because of this – but it’s early days.”

ICT support officer, Wilmslow

All the schools seemed to think that the Tablet PCs had had an impact on learning by increasing:

- access to and the range and diversity of resources (identified by four schools)
- learners' independence, including choosing to do extra work outside school time (five schools)
- the variety in the lessons, which often meant making lessons more interactive and/or involving more collaborative work (five schools)
- the differentiation of work to meet the full range of needs of learners (four schools).

There seemed to be universal agreement that using the Tablet PCs had a positive impact on ICT competence: the greater the level of use of the Tablet PCs, the greater this impact. Evidence about the impact of the Tablet PC on learning outcomes in other curriculum areas was less clear. Four schools identified that their use had had an impact in one or more of the core curriculum areas. In three of these schools the children concerned had had ownership of their Tablet PC for at least half a term. In the fourth, the introduction of the Tablet PCs was quite recent but represented a massive whole-school effort, involving all staff (most of whom had their own Tablet PC) and all the children (who shared class sets of Tablet PCs). A fifth school thought that using the Tablet PC had probably had an impact in maths. This view was echoed by the children, who felt that the Tablet PCs helped them learn by making learning more fun and by giving them different experiences in a number of subject areas.

Six of the schools felt that it was too early to say whether or not the Tablet PCs were affecting learning outcomes (other than in ICT). However, there seemed to be a general feeling that Tablet PCs were likely to have a positive impact owing to their effect on motivation, self-esteem, concentration and so on, which three of the schools explicitly mentioned.

"There are year on year tests. On average [in the past] the test results go up by 2 sub-levels; 60% went up by 3 levels last year [when the children had their own Tablet PCs]."

Teacher, St Francis



'In science there was no difference between students with and without Tablets last year; however the end of year exams showed that students with Tablets generally outperformed those without.'

ICT questionnaire, Cornwallis

"They love the Tablet PCs. Using maths games as a whole class has motivated them to improve mental and oral numeracy skills as a starter."

ICT consultant, Engayne

Features of Tablet PCs

We explored a range of ‘features’ of Tablet PCs in order to see the extent to which the features were used and what impacts they appeared to be having on practice across the case study schools.

Type of Tablet PC

Eight of the schools had slate Tablet PCs, and one of these also had convertibles for staff use. The other four schools had convertibles: three had the type with a pivot/twist design and the fourth had the sort with a keyboard that could either be pivoted/twisted or removed totally.

Five schools had the model of Tablet PC they chose for themselves. Two of these schools chose slate-type machines, while the other three chose convertibles. In the other seven schools an external party (the LEA, their ‘partner school’ or the project they were involved in) determined the make and model of the (initial) machines. The decision about whether to go for slates or convertibles seemed to depend on four key factors: cost (slates were perceived as cheaper); reliability (several schools thought the pivot mechanism would be too flimsy and the slates more robust); versatility (convertibles offered ‘the best of both worlds’); vision

(several schools specifically wanted to take advantage of the potential they perceived in the more immediate and intuitive pen interface and were concerned that keyboards might detract from this).

Several schools reported that there were reliability issues with early models, but all these comments seemed to refer to slate-style machines from a single manufacturer.

Pen versus keyboard

Where Tablet PCs were for staff, the schools usually supplied keyboards (five schools used convertibles; two used slates with external keyboards; one school provided one staff slate-style Tablet PC without keyboard). Where schools were providing students with Tablet PCs, these tended to be slates (seven schools out of 10). Of these schools, five did not provide external keyboards or docking stations for students.

Even where keyboards were available, most schools claimed that the pen was the predominant mode of use by students and by staff when using the Tablet PCs during lessons – and our observations generally confirmed this. Staff tended to use the keyboards outside lessons, and students used them for longer pieces of writing and to log on or enter URLs. Even where keyboards were being used, the pen was usually the main means of navigation. When the Tablet PCs were being used ‘on the move’, such as in PE lessons, or being passed around as part of a whole-class lesson, they were almost always used in slate mode, with the pen as the means of input/navigation.

“The Tablet PC is particularly useful in subjects like maths and science where the use of a pen has considerable advantages over a mouse. Diagrams can be annotated more easily. Templates can be filled in which saves the students time in copying diagrams. It is possible to insert whole past papers into Journal which students can then directly work on. The technology allows accelerated and more independent learning.”

Deputy Head, Invicta

Schools tended to provide keyboards for staff and slates (without keyboards) for children. Staff used the keyboards for preparation and administration, but used their own Tablet PC in slate mode in the classroom. Children predominantly used pen input, even where keyboards were available, except for longer pieces of writing. However, handwriting recognition was not used extensively in most cases.

Many of the schools used their Tablet PCs for art activities and/or used the drawing facilities when taking notes, but used audio facilities less extensively. There was a lack of software that took full advantage of Tablet PC features, and schools wanted more (independent) advice about software. The range of ‘negative features’ of Tablet PCs identified related to their screens, battery life and problems with pens.

Handwriting recognition

There is a significant difference in handwriting-recognition facilities between the original Tablet operating system and Tablet 2005 (for more details, see **What is a Tablet PC?**, p1). Most of the case study schools did not know which version of the Tablet PC system they were using or what the differences were between them. Seven of the schools were using the original Tablet operating system, three were using Tablet 2005, and two were using a mixture of the two systems on different machines.

Nine of the case study schools reported little or no use of the handwriting-recognition facility. The remaining three schools, all of which were using the original Tablet operating system, made some use of it. In one case this was focused on improving children's handwriting. In both the other cases it seemed to be a matter of student choice about whether to use a keyboard (external or onscreen) or handwriting recognition. In two of the schools which reported little or no use, there were specific individuals who did make extensive use of the handwriting recognition. In one case this was a member of staff who used it when on a course or at meetings to take notes, which she subsequently converted to text (using Tablet 2005). In the other school, a child with motor control difficulties made extensive use of the handwriting-recognition facility, and this was seen as having transformed her access to the curriculum – improving the quality and quantity of her writing as well as improving her handwriting on paper (using the original Tablet operating system).

'Tablets offer an extremely powerful multi-sensory learning experience, stimulating different parts of the brain. Pupils can see, hear and touch their work as it progresses, becoming completely absorbed and fascinated in the results of their own actions.'

Headteacher, Green Lane (Toshiba 2004)

Several schools commented that they did not use the handwriting recognition because it was not good enough. All of these schools were using the original Tablet operating system, and some of their specific criticisms (such as that you could not tell whether a word had been recognised or not in the input panel) have been resolved in Tablet 2005.

Several of the primary schools commented that handwriting recognition was something that they wanted to explore in more depth. A member of the senior management team in one school said that she was not unhappy that they had not yet made as much use of handwriting recognition as she had expected because she did not want the Tablet PCs to be seen as 'limited to writing things down'.

Talking about using handwriting recognition, a teacher reported that "the children felt that even the mistakes look neat" and "even when rushing it looked neat."

Teacher, Engayne

Diagrams and symbols

Eight of the case study schools explicitly mentioned and/or provided evidence in their portfolios of using their Tablet PCs for art activities. This included six of the seven primary schools. In this context, pen input was seen as representing a significant advantage over other input devices, and particularly over the use of a mouse or track pad.

Seven schools identified that they made some use of the ability to add diagrams and symbols to notes or pieces of work. In three schools this use was widespread. These three were all schools in which the students had ownership of their Tablet PCs and made extensive use of them in all of their lessons. In one other school, a member of staff reported making extensive use of diagrams and symbols in his teaching of maths, using a Tablet PC and data projection.

Specific software

Nine of the schools specifically mentioned using Journal, which is supplied with Tablet PCs. Two mentioned using OneNote. Seven schools mentioned using Office 2003, which provides (handwritten) annotation facilities that take advantage of pen input when used in conjunction with Tablet 2005. Several schools mentioned art packages, which had been adapted to take advantage of pressure-sensitive screens (and/or graphics pads). Two schools mentioned using one or more of the Tablet PC PowerToys, which can be downloaded free of charge from Microsoft [<http://www.microsoft.com/windowsxp/downloads/powertoys/tabletpc.msp>]. The PowerToys include a range of utilities and applications that enhance and/or take advantage of the features of Tablet PCs such as Art Tool, Calculator, Drawing Animator, Hold Tool, Ink Screen Saver, Physics Illustrator, My Font Tool, Power Paint Tool, Snipping Tool, Music Composition, Writing Practice and a range of other applications, including a collection of games.

Schools mentioned a wide range of other software, but this all appeared to be 'conventional' PC software, and was not designed to take advantage of the features of Tablet PCs. The shortage of specific software that takes full advantage of the features of Tablet PCs was raised by several schools, as was lack of access to 'unbiased' advice about suitable software.

Audio facilities

Six of the case study schools reported making some use of the audio facilities built into their Tablet PCs. Half of this use involved 'feedback' in the sense of having text that the children had written spoken back to them. In two other schools the children recorded themselves speaking and/or making music. In two schools the children used the recording and playback facilities, combined with the mobility of the Tablet PCs, to record information. For example, children kept an audio diary during a school trip.

Most of the use of audio facilities could have been replicated on a desktop or laptop machine with microphone and speakers, and running the same software. However, the convenience of having all of the audio facilities integrated into one mobile unit appeared to be an important facilitating factor.

Other features

Size and form factor were universally seen as important features. All but one of the schools which provided staff ownership of Tablet PCs chose convertible models, as they regarded the keyboard as essential for staff use. In most cases, convertible-type machines were considered preferable as they offered maximum versatility, providing the best of both worlds. Nonetheless, where schools were providing machines for students, they tended to provide slate models. This may have been because slates are generally cheaper than convertibles, but in at least one case it was in order to ensure that students utilised the features of Tablet PCs fully and did not just use them like laptops.

"When you're writing on the screen you have to stop and pick it [the Tablet PC] up so you can read your writing."

Student, Wylde Green

The Tablet PCs' small size made it easy to incorporate them into normal classrooms. Used in slate mode, they were seen as being very portable, which was a particular advantage when using them with a wireless data projector as it meant that the Tablet PC could be passed to children. Schools commented on the more natural interaction between children and the computers in slate mode: children could use them on their laps, on the table or, if they were standing up, held in one arm.

Schools identified several negative features of Tablet PCs. The schools were using a mixture of 10.4" and 12.1" screens. While most schools felt the size of the Tablet PCs was about right, two felt that the screen size (12.1") was too small. Lack of screen brightness and problems with glare were issues in half the schools, particularly when the Tablet PCs were being used outside or where internal lighting was very bright. Some schools felt that this was largely overcome by the ability to angle the screen.

Most schools considered battery life too short. While some indicated that their Tablet PCs lasted the whole of the morning or afternoon session, most reported battery life of roughly two hours (give or take 30 minutes).

Problems with pens were reported in several schools, either because they broke (two schools) or were lost too easily (in the case of Tablet PCs where the pen was not tethered).

Two schools wanted weatherproof Tablet PCs, while a third had overcome this problem by using their Tablet PCs inside see-through plastic zip wallets.

"The size and shape of the Tablets encourage empathy with the machine; the children 'wrap themselves around them!'"

ICT co-ordinator, Queensbury

'Tablet PCs free up other school resources. ... Students can use their Tablets in any classroom.'

Field notes, Invicta

Complementary technologies

It was clear from the case studies that there were certain infrastructural requirements and other technologies that significantly enhanced the value of Tablet PCs and/or facilitated their effective use. We explore these here.

Wireless networking

Ten of the 12 case study schools were using their Tablet PCs with a wireless network. All ten of these schools considered that wireless networking was essential and that using the Tablet PCs without it would render them ineffective. In the two cases where wireless networking was not available, the schools were making good use of their Tablet PCs, but were aware of limitations that this imposed. The wireless networks were used to access the internet, school servers and printers, and to install software.

Memory sticks

Memory sticks were considered essential by one of the schools which did not have a wireless network, as well as by two other schools (for staff use in one of these). Nine of the case study schools used memory sticks to some degree. They were seen as a failsafe for when there were problems with the wireless network. In one school, children used them to share what they were doing with their peers.

Data projectors

Eight of the case study schools thought that having data projection with the Tablet PC was essential or very useful. Six of the schools had experience of using data projection with a wireless connection to their Tablet PCs. Only two of the schools did not use data

projection with their Tablet PCs, in one case because the class teacher preferred to use her personal laptop instead and, in the other, because there were technical problems getting the Tablet PCs to work with the data projector and so staff were using their laptops instead. In several schools the children's Tablet PCs were connected to the data projector so that everyone could share their displayed work. All of the schools had experience of using data projectors (with or without interactive whiteboards) with wired connections to desktops and/or laptops.

A data projector plus Tablet PC was generally seen as being better and more cost effective than either a laptop and data projector or an interactive whiteboard, particularly where there was a wireless connection between the Tablet PC and data projector. The advantages of a Tablet PC with wireless connection to a data projector over an interactive whiteboard included that the teacher could move around the classroom rather than having to stand at the front; the Tablet PC could be passed to children (in a way that would not be possible with a laptop), which caused less disruption than children coming out to the whiteboard; everyone could see what was happening as there were no problems with shadows on the whiteboard; and you did not have to worry so much about where you positioned the whiteboard (because accessing it was not an issue). One school also found the touch screen on the Tablet PC far more sensitive than the interactive whiteboard.

Children in one school explained why they preferred using a Tablet PC and data projector than the interactive whiteboard:

"Its easier to write on than the whiteboard, nicer feel."

"There's no big shadow on the Tablet like there is on the whiteboard when you write on it."

"People can't see what you are writing on the whiteboard until you are finished cos you are in the way."

Year 6 pupils, Wylde Green

In another school children defined a Tablet PC by saying "A Tablet PC is a little interactive whiteboard."

Year 3 pupil, St Peter's

"Wireless operation [with the Tablet PC] was the dream option for the short time that it worked. ... Interactive whiteboards rank second – they work faultlessly and are inspirational for the children. Data projection and screen offer useful visual aids but lack the magnetism of the interactive function."

Headteacher, Green Lane

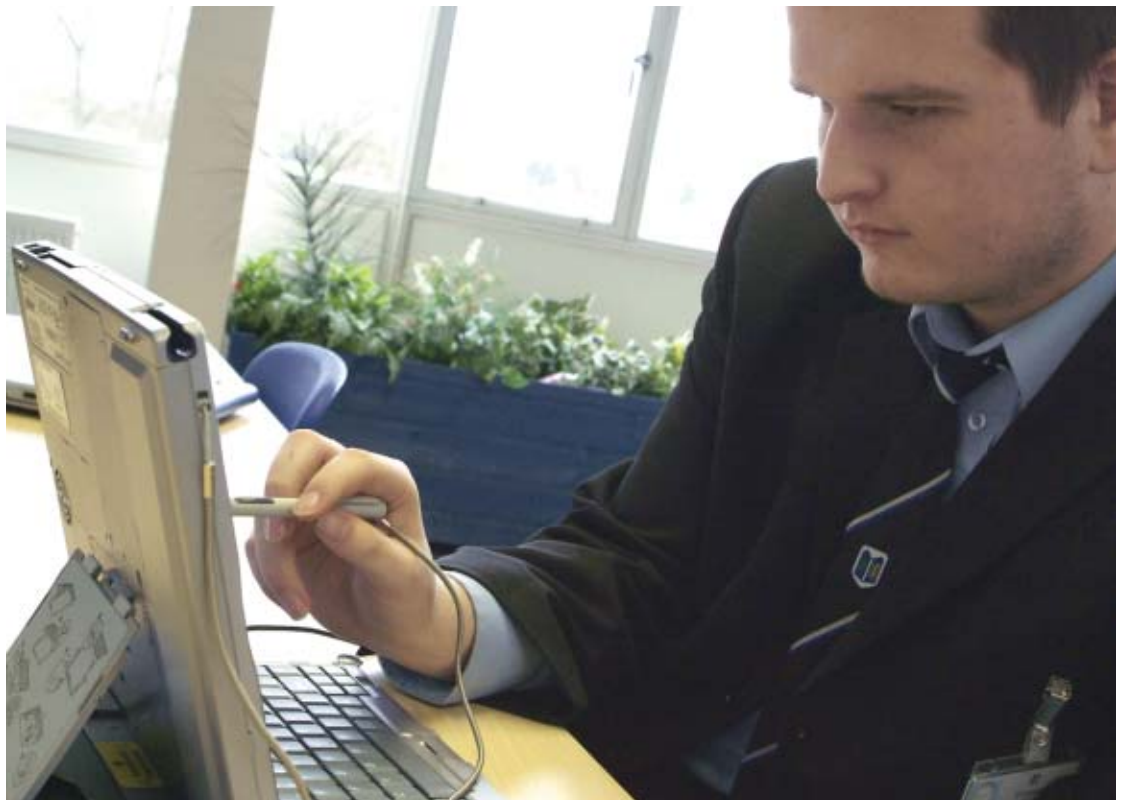
Other 'peripherals'

Five schools saw a CD drive as a useful alternative means of accessing resources and/or saving work, for example when the wireless network was not working. Four schools had docking stations, although we saw them in use in only one school, which explained that they were used either when the Tablet PCs' batteries were running low or to physically connect to the network when the wireless connection was not working. One school mentioned the importance of having stands which their (slate-style) Tablet PCs could be placed on to overcome problems with screen glare. In two other schools we saw children using pencil cases or books to achieve a similar effect.

Five of the schools explicitly mentioned having charging trolleys. These seemed to be seen as essential in those schools where classes shared sets of Tablet PCs. A small number of schools used digital cameras with their Tablet PCs and felt that this added value.

"Teachers can prepare lessons more easily, making use of the internet and by sharing and storing resources on the school network. Electronic resources and good software are cost effective as teachers are realising that they can find many resources on the internet thus reducing the need to purchase physical resources like reference books and posters that can easily become out of date."

ICT consultant, Engayne



Thresholds

We asked schools to identify the minimum and optimum levels of resourcing for Tablet PCs to have an impact.

Staff use

There was general agreement across those schools that commented on resourcing levels for staff that staff ownership was essential in order to enable preparation and to maximise 'familiarisation opportunities'. In addition, these schools all agreed that a critical mass of staff needed to be involved. This might mean all the staff in a primary school, or all the staff in a department in a secondary school. This was seen as important not only so that staff could support each other and share ideas, but also to maximise the value of shared planning, record keeping and other administration systems.

was sufficient if being allocated to a specific individual as part of their SEN provision.

For those schools where student ownership was not seen as being essential, there was general agreement that the amount of time that each student spent using a Tablet PC needed to be enough so that they did not have to relearn how to use them each time. However, respondents were generally unclear about how much time this might mean: while several schools thought that it would need to be at least an hour a week per child, others seemed to think the figure should be considerably higher than this.

Minimum number of Tablet PCs schools thought were required to have an impact	Number of schools	
	Primary	Secondary (including special)
6-8 (enough for a whole group to have one each)	3	0
Enough for half the class to have one each or for the whole class to use them if working in pairs	3	0
Enough for the whole class to have one each (plus spares)	0	2
Student ownership for all children in one class	1	0
Student ownership for all children in one year group	0	1

Student use – optimum level

One primary school thought that having eight Tablet PCs was best, as this would allow each child in a withdrawal group working with a teaching assistant to have their own. All the other nine schools that provided Tablet PCs for student use thought that each child having their own Tablet PC, when they were being used, was the ideal. There was a split between those schools which thought student ownership was optimal (three secondary and one primary) and those which felt that this was unnecessary because students could not and/or should not use them all the time (five primary). These five primary schools wanted one or more class sets, though several of them also expressed a wish to have additional machines in order to allow for spontaneous use, repairs, home use and community involvement.

Student use – minimum resourcing levels

Perhaps not surprisingly, schools' views on the minimum level of resourcing generally reflected the level of resourcing that they themselves already had, except in one case where they felt that they needed more Tablet PCs in order to reach the minimum threshold for impact. The table above summarises the responses from the 10 schools that provided Tablet PCs for student use. Two of these schools, one primary and one secondary, also indicated that one Tablet PC

“Yes, this [staff ownership] is crucial because we have to do the lesson development in our own time so need to have access.”

Teacher, Coleshill

There was general agreement that there needed to be enough Tablet PCs for a whole group (which might mean a small group within a class, a whole class, or a whole year group) to be able to use them at one time. However, some thought students needed one each during the sessions where they were using Tablet PCs, while others considered that the machines could be shared between pairs of children.

While many of the schools found the notion of having too much resourcing rather odd, several of the (primary) schools said they would not want children working on screens for too much time “...because a variety of approaches to learning is essential.”

Teacher, St Willibrord's

Student 'ownership' was seen as being optimal in one primary and three secondary schools.

Support

In examining the data, it was clear that ‘support’ was a significant issue. Three distinct areas were evident: start-up issues; on-going technical support; cost issues. (We discuss training in **9 – Staff and student development**, p17.)

Start-up issues

Eight of the schools specifically mentioned the difficulties associated with setting up the Tablet PCs. Two of these schools identified the amount of planning and preparation that they had needed to do before the machines were rolled out to staff and students. The other six had extensive problems, most of which were not specific to Tablet PCs and which appeared to relate to configuration issues, wireless networking and/or connecting to servers. In several schools these problems carried on for months, and had a serious impact on the ability to use the Tablet PCs as well as on staff and student morale.

support, had increased considerably – though several of them also acknowledged that this was at least in part due to the overall increase in the number of computers. Two schools, where there were large numbers of machines and where staff and/or children had ownership of their Tablet PCs, said that immediate or just-in-time support was essential. Several schools mentioned the time taken to repair or update machines as an issue, while others highlighted the need to have replacement Tablet PCs available.

Tablet PCs do seem to have particular on-going support issues, many of which are related to their mobility (and which thus may also apply to laptops). For example, two primary schools talked about the need for a teaching assistant or ICT technician to set up the equipment in the classroom. Others talked about issues of battery management. A number of schools commented on the unreliability of (early) Tablet PCs, although one other school thought them more robust than laptops. Several schools mentioned the cost of replacing damaged or lost pens.

Cost issues

Tablet PCs are more expensive to buy than laptops of an ‘equivalent’ specification and this was a major barrier to their uptake. While all the schools said they would like to extend their use of Tablet PCs, which they all seemed to feel were better than laptops, every school identified price as being an issue and, because of this, four have already bought or would in future buy laptops or desktops instead. Five of the schools thought that Tablet PCs were cost effective. Two schools felt that they were not currently taking full advantage of the potential of Tablet PCs, but that the machines would be cost effective once they were exploiting them fully. Three others did not think that their Tablet PCs were cost effective at present. Buying a Tablet PC and data projector was seen by many of the schools as cost effective.

“Storage of this equipment needs careful consideration. We spent about 20% of the total budget on security measures including lockable trolleys, shop front shutters for cupboards, Kensington locks, screaming alarms for projectors and CCTV – all of this in what might be considered a relatively low-crime area. It is vital to have safe storage and effective staff training on being vigilant about looking after the equipment. Engraving of equipment prior to distribution is necessary...”

ICT consultant, Engayne

Several schools mentioned the need to budget for the cost of software, training, security and peripherals for Tablet PCs. The last two issues seemed to be particularly important, because of the portability and desirability of the schools’ Tablet PCs, and the fact that they did not have features such as internal CD drives.

On-going support

Nine of the schools identified that the level of technical support required, particularly on-site

“I’d say that Tablet PCs are 50% per Tablet more expensive to purchase and maintain – but we are now getting some returns. They are very much more cost effective as they offer a very flexible solution worth the extra money compared to laptops or desktops.”

ICT team, Engayne

Staff and student development

We looked at the staff and student development that had been provided in the case study schools and how easy or otherwise staff and students found using the Tablet PCs.

Many of the issues raised in relation to staff development were those that would be raised in connection with any change in practice or technology:

- It needs to be related to the level of competence/confidence and needs of the users
- It should focus on how to integrate the technology into practice, not just how to operate the software
- There needs to be sufficient time to practise, experiment and share ideas and resources.

In many of the case study schools, the training issues were not related to the Tablet PCs themselves but to how to use the school servers, local area network or software.

Staff or students who were already confident users of computers found using Tablet PCs intuitive and adapted to them very rapidly. In three cases the teacher(s) concerned had little or no explicit training and learned how to use the Tablet PC quite easily on their own. Six of the schools commented on how quickly and easily the students learned to use the Tablet PCs, which they thought more intuitive than other PCs. However, training was needed on how to manage the equipment. This was particularly true where the Tablet PCs were shared and routines needed to be established for issuing them, battery management and so forth.

Five schools said that staff needed more support or time to experiment in order to understand the Tablet PCs' potential. Several schools would have liked to be given examples of how other people were using them. One school mentioned the importance of having 'champions' who were given extra time to experiment and then cascade ideas to other staff. The importance of 'champions' was also evident in many of the other schools. Two schools identified the need for a critical mass of staff to be involved in using Tablet PCs, as this led to peer-to-peer support.

Teaching assistants or ICT technicians in at least four schools provided regular support to staff and students in the classroom. Two schools explicitly mentioned using students ('expert users') to support their peers and, sometimes, staff. Staff in two other schools acknowledged learning to use the Tablet PCs 'alongside the children', which appeared to mean that they learned from the children.

"Would you buy a £250,000 Bentley and never teach the person how to drive it properly? Well the same goes for the Tablet PCs. Effective training for staff at our school has been given a solid foundation by three CPD days focusing on software awareness, curriculum application, the pedagogy of Tablet PCs and presentation technologies..."

ICT consultant, Engayne

"It's not the Tablet use itself – it's the need to save to the networks [the Tablet PCs were set up so the children couldn't save to Tablet]. You need to train them to save work at intervals and keep a check on the network connection. ... I used the Tablet with the interactive whiteboard to demonstrate – children copied on theirs."

Teacher, St Francis

"After initial training we realised the enormous potential of using Tablets in all curriculum areas. ... Time was needed to play and explore."

ICT co-ordinator, St Mary's

'Intuitive for some but difficult for others, especially using the pen.'

Field notes, Invicta

"If familiar with ICT, not much training is needed. The pen is easier than the mouse."

Teacher, Queensbury

Comparison of mobile devices

Where the case study schools had experience of using laptops as well as Tablet PCs, they were asked to comment on the relative pros and cons of Tablet PCs in relation to laptops.

Convertible-style Tablet PCs were seen as being more versatile than laptops – providing the best of both worlds. While slate-style Tablet PCs are less flexible than convertibles, they were recognised as having a number of advantages over laptops. These advantages of Tablet PCs (in slate mode) included:

- taking up less space in the classroom
- being more mobile, both in terms of being easier and quicker to pass around and also for writing 'on the go'
- providing a 'more natural' way of working, both in terms of the pen/screen interface and greater flexibility about the positions in which they could be used (on your knee, on the desk, in one arm)
- using a pen being more intuitive, and easier than a tracker pad
- being more robust (although several schools had problems with early models).

"It's important to see Tablets as a different kind of device from a laptop. ... We made a deliberate decision not to provide keyboards for students."

SMT, Cornwallis

- the lack of a CD or floppy drive, although one school identified this as an advantage, as it made it more difficult for students to install their own software (and viruses)
- and, most importantly, the cost differential – Tablet PCs being significantly more expensive than laptops of similar specification.

Inevitably the lack of keyboard on slate-style Tablet PCs was seen as a disadvantage by some schools, while others saw it as a positive benefit, as it meant that children were not 'distracted' by trying to type.

Most of the schools seemed to think that Tablet PCs had more to offer than laptops. This appeared to be related to the feeling that the Tablet-specific features such as pen input and enhanced portability combined with other features such as wireless networking, and audio recording and playback, meant that they were at the very least an 'enhanced laptop'. There was a general feeling that their use was qualitatively different from the use of laptops or other computers. This was not reflected in much of the practice that the researchers observed, but several of the schools explained that this was because they were just starting to understand the potential and experiment with different ways of using them.

'The college has a specific view of teaching and learning which is to emphasise the role of teachers as facilitators, to encourage independent learning by 'empowering students'. The use of Tablets fits nicely into that perspective.'

Field notes, Cornwallis

However, a number of disadvantages of Tablet PCs compared with laptops were also identified. These included:

- that screens were smaller and less easy to see
- that battery life was not as good as expected

"It's a lot easier to move around with Tablets than laptops – I would worry more about sending them outside unsupervised. Laptops seem more fiddly, easier to damage."

Teacher, St Francis

"The machines are robust and a reasonable weight and size, and this makes them ideal for transporting in the children's own bags. This is important for security as the students only have to carry one bag, and do not attract attention by carrying a bag that looks like it is designed for a laptop."

ICT co-ordinator, Queensbury

Learning spaces

We explored the impact of Tablet PCs on the physical and temporal spaces within which staff and students worked – when and where learning took place and the extent to which virtual spaces were utilised.

Two different types of impact on where learning took place were evident.

Firstly, there were changes in the use made of existing spaces, which included:

- freeing up rooms which had previously been ICT suites (two schools)
- using ICT in spaces where it had previously not been used, such as:

classrooms (Tablet PCs were used in 'normal' classrooms in all 12 schools, although in some cases one or more computers had previously been located in the classrooms)

the school field, the gym, and other spaces which lacked desks or other classroom furniture (five schools explicitly stated that they used Tablet PCs in one or more of these locations, and two others implied this)

- extending learning outside the school, including enhancing learning on field trips, as well as in the children's homes (mentioned as happening in three schools and desired by six others).

Secondly, seven schools identified changes that were needed to the design or organisation of the classrooms. These included:

- rewiring rooms to make power points available at all desks or tables

- rearranging furniture, for example to allow for charging trolleys
- increasing security such as secure cabinets
- adjusting lighting, for example by installing blinds and/or more flexible lighting.

Another school was part of a 'Classrooms of the Future' project, which involved designing the learning environment from scratch, incorporating features to support the use of Tablet PCs.

All but two of the schools made use of wireless networking to provide staff and/or students with access to internal school servers and the internet. Five of the schools specifically mentioned that they had virtual learning environments, though in at least two cases these were in the early stages of being implemented. The Tablet PCs in conjunction with wireless networking provided an interface between the physical learning spaces and the virtual ones. However, there appeared to be only three schools where Tablet PCs were used from outside school to access the school's resources, and even in these cases there was limited evidence of any significant use of the Tablet PCs in this way.

There was some evidence in a small number of schools that the Tablet PCs did affect when learning took place, by extending learning outside formal teaching sessions. This was linked either with the provision of homework clubs (in the case of one school with a small number of Tablet PCs) or personal ownership (in the case of three schools). The Tablet PCs were also seen as loosening timetabling constraints, in terms of staff not having to worry about the availability of the ICT suite and, but less frequently, in moving towards a more personalised or project-based approach to learning.

"Where a pupil has a Tablet and takes it home this often impacts on the family and we find that other siblings use the Tablet in the home environment. In some cases parents use them too."

ICT co-ordinator, Cornwallis

"There are no restrictions on time or place, other than special curricular activities like swimming."

Teacher, St Francis

"As a multi-site school the mobility had really strong appeal as the Tablet PCs offered anytime anywhere type use."

SMT, Engayne

'The Tablets have generated a spare classroom and they support the way the school is organised rather than controlling it ... without having been a Pathway school for access [they have lifts and hoists in the four level building] we couldn't have gone for Tablets as without the lifts we couldn't have got the Tablet trolley to KS2 classes.'

Field notes, St Peter's

Lessons learned

We explored the lessons learned from using Tablet PCs and what teachers wished they had known before they started using them.

The schools identified a range of unexpected positive outcomes. For example, there were generally positive views of the robustness of the Tablet PCs (other than for some early models), which in at least one case allowed them to be inconspicuously transported to and from school. The absence of keyboards, which could be seen by many as a restriction, was in fact reported as sometimes being positive because it encouraged the use of Tablet-specific facilities such as handwriting input using the pen. The flexibility of digital ink in allowing teachers and students to add handwritten notes, pictures and diagrams to work was also seen as being very valuable. There was almost universal agreement on the motivational aspects of Tablet PC use for pupils, with improvements in concentration, self-esteem and communication skills, and the development of researching and recording skills. The only exceptions to this appeared to be related to technical obstacles, which created frustration and reduced enthusiasm.

“A teacher with limited knowledge of how to use the Tablet has serious stress level increase as she waits for the log on stage only to find the internet is down, or work completed at home hasn’t synchronised yet.”

Teacher, Coleshill

- **The need for training**

This was described as essential, though it appeared that the issue was often less to do with using Tablet PCs *per se* and more to do with learning new software and how to use the local area network. One school commented that three days’ training had not been enough, and that it needed to be targeted better with input from teacher specialists.

- **The importance of confidence building**

In addition to providing appropriate training, adequate support and a reliable infrastructure, schools suggested that it was important for teachers to build their confidence by sharing ideas and resources, or starting smaller projects to allow them to try out ideas and experiment.

- **The importance of management/security issues**

Several schools mentioned the need to have proper procedures and routines in place for issuing Tablet PCs to students, tracking where they were, recharging batteries, saving work, collecting in equipment, dealing with repairs and so on. Schools often underestimated the time and resource necessary for this. Storage and security need careful consideration. One school recommended spending 20% of the Tablet PC budget on security.

‘The children generally found the use of the Tablet PCs easy, enjoyable and motivational.’

Field notes, Wylde Green

There was a consensus on the importance of planning to ensure best use of Tablet PCs. Issues raised were as follows.

- **The need for the development of a good infrastructure**

Original purchasing decisions needed to include adequate and appropriate peripherals. The location of wireless network points needed to be considered; and networks, servers, and Tablet PCs “need to be compatible, reliable and sufficiently robust” (St Peter’s).

“Tablets open up new ways of working. In particular they can encourage different teaching styles and support different learning styles.”

ICT co-ordinator, St Mary’s

“When I was given it [the Tablet PC] I took it home and just played with it. It was really easy to use. I was surprised how you could do everything on it that you can do with a real computer.”

Year 11 student, Queensbury

- **Reliability**

Once they had been successfully set up, Tablet PCs (except in the case of some early models) were generally perceived as being as reliable as other mobile computers. Battery life was considered too short, and this was seen as problematic in five schools. Despite being perceived as unreliable in several schools, wireless networks were still seen as essential by all ten schools which were using them.

- **The need for support**

The importance of sorting out technical problems was recognised. Nine schools mentioned the importance of, and increased demand for, technical support. This support was regarded as particularly necessary at the early stages of implementation, to avoid staff becoming discouraged when technical issues dominated. Two schools used student 'expert users' both to resolve technical issues and to encourage collaborative working. Several schools commented on the time taken to install and/or upgrade software on the Tablet PCs.

- **Time**

Several schools reported insufficient time for staff to prepare resources and lessons and/or to configure the Tablet PCs or provide staff development and ongoing support for the Tablet PCs' use.

- **Logistics for managing student working**

Students need locations for saving their work and if this is done via a wireless network they need to save regularly and while connected. Several schools highlighted the importance of memory sticks, which were often seen as a failsafe in case there were network problems. One school highlighted the benefits of saving versions of work, allowing teachers to build up a profile which could be useful for assessing progress and for parents' evenings.

"Order more pens!"

ICT co-ordinator, Queensbury

- **Visibility of screens**

Two schools mentioned the need for larger screens and around half mentioned problems of visibility due to lack of screen brightness and/or glare.

- **Other issues**

A primary school working on an outreach programme with its local secondary school commented on the positive impact of inter-school working, highlighting that the loan of equipment allowed the possibility of trying out equipment before purchase and extending help and support.

Tablet PCs were recognised as having an impact on practice by opening up new ways of working and, when used in conjunction with the internet, allowing access to a wider range of resources. The use of Tablet PCs was considered to have enhanced the pace of lessons, but also to have led to the need for more classroom support. As learning support assistants often provided such support, Tablet PCs were seen as increasing the range of skills demanded of these staff.

Some comments were made about the importance of fit between the school's ethos and implementation plan, for example in terms of the personalisation of learning and the personal ownership of Tablet PCs.

Some comments suggested a gradual introduction of Tablet PCs to selected groups of staff and/or students – perhaps starting with the most experienced, who could then share 'good practice'. The importance of avoiding preconceptions about how Tablet PCs should be used was noted, in order to allow individuals to experiment and find out what worked for them. Many of the schools recognised that they needed to explore how best to fully utilise the potential of the Tablet PCs.

"If we were starting to introduce Tablet PCs again we would begin more modestly with a phased introduction, perhaps issuing to one group and then when established increasing the number of groups using them. This allows the process to be more easily managed and supported."

Deputy Headteacher, Invicta

'The strengths of Tablets are as note takers and presentation developers which are easily personalised to meet individual student and teacher needs.'

Field notes, Cornwallis

Research conclusions

This section summarises the key research findings emerging from the case studies.

There was a strong feeling in the schools that Tablet PCs have the potential to enhance learning and that this goes beyond what is possible with other technologies. On the basis of the evidence collected, this does indeed seem to be the case. However, in many instances this potential was not being fully realised, and much of what we observed could, in the researchers' view, have been achieved with conventional laptops. The contexts in which the potential of Tablet PCs seemed to be most fully realised were ones in which:

- teachers and students had encouragement and time to experiment and be innovative in the ways they used the Tablet PCs (this was closely associated with 'ownership' of the equipment)
- there was a sufficient critical mass of Tablet PC use, although there were differing views on how many Tablet PCs this meant and how long each child needed to spend using them each week
- staff and students were encouraged to share their experiences, ideas, expertise and resources
- the school wanted to integrate ICT across the curriculum and/or wanted to free up space by replacing their ICT suite with a class set of Tablet PCs
- the school wanted to move to more personalised and creative ways of working, in which independence, research and collaborative working often played a significant role
- the school wanted to stretch the boundaries of the classroom to include field trips and the home.

All of this assumes the provision of a robust ICT infrastructure, including wireless networking, reliable servers, (immediate) technical support and pedagogically focused staff development.

Many schools highlighted the advantages of using a Tablet PC with a data projector, especially if connected wirelessly. They saw this as a better solution than computer and interactive whiteboard.

The importance of staff and student motivation should not be underestimated, and it was clear that Tablet PCs had a very positive impact in this regard (only diminished when there were technical problems). Students appeared to relate to Tablet PCs differently from the way in which they related to other computers. This may have been due to the more 'natural' way in which they could physically interact with the Tablet PCs, in terms of variety of position (on their knee or held in one arm, for instance) and also the immediacy and intuitive nature of using a pen on the screen. There is significant potential for the development of software that makes use of these features of Tablet PCs.

'The school vision is about 'putting learners first' – a move to independent learning with teachers as facilitators. Tablet PC plus wireless network plus access from home all combine to make this possible.'

Field notes, Cornwallis

"Being able to work at a desk while browsing web pages is an enormous advantage. The children find that using the Tablets in Tablet [slate] mode, and navigating around pages using the pen, is faster than using the touch pad. They also seem to find it more natural. Having the large screen and a data projector makes it possible for me to demonstrate clearly what I want them to do. I can also show the children's work to the whole class via the projector."

Teacher, Engayne

"Their [the children's] researching has greater depth as they now consult a wider number of sources ... learning is more in the classroom and less in the ICT suite and is more 'hands on' – that is not just listening to or watching teacher presentation – learning is more multi-sensory and kinaesthetic. ... There is much greater use of ICT and they are certainly more competent and confident ICT users but it's a bit early to say about other areas."

Teacher, St Willibrord's

Further research

These case studies have suggested that Tablet PCs do have the potential to enhance learning. However, that potential is not currently being fully realised. Further research is clearly needed.

Handwriting recognition

While handwriting recognition is one of the key features that attract schools to Tablet PCs, particularly where they cater for younger children, it is currently not used extensively. It would be valuable in the short term to investigate in more depth the use of handwriting recognition, particularly with the release of Tablet 2005 and in relation to other types of input devices. This should include looking at its impact on both handwriting and also the wider issues of composition and literacy.

Inclusion and gender differences

In a small number of the case studies there was clear evidence of Tablet PCs being of benefit to children with special educational needs. There is scope for further work to explore where Tablet PCs might be of particular benefit in providing access to the curriculum for children who might otherwise be excluded from it.

The case studies did not provide any clear evidence in relation to gender and the use of Tablet PCs. However, given the apparently more personal and intimate nature of Tablet PCs, it seems reasonable to surmise that they might represent a less gender-dominated form of computer. Indeed the researchers are aware of a limited amount of anecdotal evidence that suggests that Tablet PCs help to overcome some girls' reluctance to use ICT.

Thresholds for use

In a context in which most schools will not be able to provide ownership of Tablet PCs for all their students, it would be valuable to investigate further the thresholds for Tablet PC use required for optimal benefits, given different deployment models.

Exploring the potential

In the short term it would be valuable to provide opportunities and mechanisms for further sharing ideas about Tablet PCs and experience of their use in ways that leverage their unique potential in education. In the longer term, as schools have more time to explore Tablet PCs' potential and they become more embedded, further work will be needed to identify the ways in which they are being used and the impacts that these uses are having on pedagogy and learning.

"Some children don't like writing on the Tablets and prefer the tactile feel of paper. We are investigating attaching mobile notetakers to the Tablets which will allow for paper to be used but still retain the notes in an electronic form. This will also help support when a Tablet is forgotten; the notes can still be made and placed onto the Tablet at a later time."

ICT co-ordinator, Cornwallis

Comparisons with interactive whiteboards

Many of the schools highlighted the value of using a data projector with Tablet PCs, and there was a common view that a Tablet PC and data projector was better and more cost effective than a laptop or desktop and interactive whiteboard. More work is needed to explore this area, looking for example at the importance of wireless data-projection solutions, the use of docking stations (with Tablet PCs and laptops) and other input devices (such as wireless mice and keyboards, or graphic pads) used with a desktop PC and data projector.

"We would really like class sets for use with Year 1 and 2 pupils as I believe they could really help with handwriting."

Headteacher, Wylde Green

A child with dyslexia and Asperger syndrome, who had problems with 'words flying off the page', set his Tablet PC with a green background to act as filter, and he also changed the font colour. "His spelling was very poor last year and he didn't write much. This year, with the Tablet PC, his writing has shown improvement."

Teacher, St Francis

The case studies

These case studies offer an insight into the different ways in which Tablet PCs are being used and highlight a range of issues related to the use of Tablet PCs in schools. They represent a brief snapshot of a subset of the practice in each of the schools and are not meant to provide a full or representative description of the full range of uses of Tablet PCs that these schools were making.

Case study index grid

	Tablets for		Tablet type	Organisation	Page
	staff	students			
Primary					
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Wilmslow	12		Convertible	'Owned' by all staff in PE department	50

St Mary's RC Primary School

Overview of school

At the time of the case study, this rural primary school had 79 pupils on roll, from 12 surrounding villages. Three of the four classes had mixed year groups. The building is semi-open plan, with classrooms, ICT suite and activity areas off a central hall. St Mary's was a member of Northamptonshire's Rural Schools Group Tablet PC project.

Description of ICT resources

Overall resources

The ICT suite had six networked computers with internet access. There were four further computers located in the classrooms and three laptops for teachers. A data projector was available for use in the classroom with laptop or Tablet PC. Additionally there was a digital camera and digital video camera.

Tablet PCs and associated peripherals

The school was provided with four slate Tablet PCs about nine months before this case study, as part of the Northamptonshire Rural Schools Group Tablet PC project. The Tablet PCs were running the original Tablet PC operating system. Much of the software was the same as on the desktop PCs (for example Office 2003, Clicker and My World) but with extra software, including Journal, RM WindowBox, Audacity and Compose.

There was one wireless network access point, located near the ICT suite. External CD drives enabled use of other resources. Work was saved to the server over the wireless network so that it could be accessed from the school's other PCs. Although children could work anywhere in the school building, they needed to move within range of the wireless access point for internet access or to save work to the fileserver. Children had a floppy disk or CD on which to save their work and occasionally needed to save on the Tablet PCs' own hard drives.

The Tablet PCs were kept in the headteacher's room on a trolley and taken to classrooms, where they were charged for use as needed. They were timetabled in the afternoons for ICT use by each class and were bookable for the remaining time. One was made available for use by an individual child as part of their Individual Education Plan (IEP) provision. There was a lot of flexibility in the use of the Tablet PCs. Overall they were in use for between 25% and 50% of the time, but this was increasing. Some classes used them more than others:

- Years 1–6: literacy, art, humanities, ICT
- Year 2: science
- Years 2 and 3: music
- Years 5 and 6: design and technology.

Using the Tablet PCs in literacy in the Year 2/3 class

Using a storyboard template

A literacy/story-writing lesson was centred on the story of Plop in 'The owl who was afraid of the dark'. The common chapter format was recapped as a class group. Next, in pairs, the pupils discussed whom Plop might encounter next and what reason this person might have to like the dark.

Four pairs of children were selected to use the Tablet PCs with the teaching assistant. A storyboard template with prompting questions was available through Journal and also on paper for the remainder of the class.



The Tablet PCs were already on tables with mains power connected. The teaching assistant reminded the children how to open the file which they then did unaided. The displayed document was fairly small on screen, so the children suggested that they enlarge it, and increased the size to 130%.

The children used the pen to write in the boxes, some printing and some joining their letters. Each pair actively discussed what to put in each box, remaining on task for the duration of the time – about half an hour. One of the pairs writing 'flying cabbage' put 'cabbage'. This didn't look right to them and they tried alternative suggestions before arriving at the correct one. At the end of the activity they needed to save the file, using the onscreen keyboard, and print it out. The wireless network did not reach into the classroom so they needed to move within reach in order to save their work.

Case study 1

The children gave the following advantages of using the pens on the Tablet PCs.

- It's better than the keyboard – it's easier to write.
- Doesn't make marks so you can change it.
- You don't have to use a keyboard or a mouse so it's quicker.
- When you work in pairs it's easier to swivel to be in front of each person to take turns.

The class teacher identified the following advantages of using Tablet PCs for this activity.

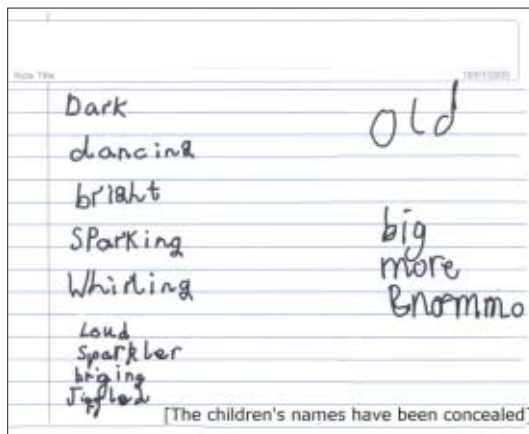
- Finished work is legible, clear and neat.
- Ideas can be changed easily.
- The children are motivated by using the new technology.

The only disadvantage identified was having only four Tablet PCs, which meant that some children were disappointed because they had to work with pencil and paper.

Hunting for adjectives

A second literacy activity involved an adjective hunt. Each child had five minutes to find as many adjectives as they could. They then wrote their list on the Tablet PC in Journal, together with their name. This activity involved a feedback session with the teacher using each Tablet PC with the data projector to discuss the words chosen.

The teacher identified the additional benefits of this as being able to validate and feedback to the children quickly. It also helped her to correct any misconceptions and identify the need for further work.



Further literacy work

Between my two visits to the school this Year 2/3 class did other literacy-related cross-curricular work on the Victorians, using Journal on the Tablet PCs to:

- write an account of Emmeline Pankhurst
- create a flow chart showing how washing was carried out in Victorian times.

Examples of Tablet PC use by the Year 5/6 class

Using the Tablet PCs for 'explicit' ICT

For the class teacher, the four Tablet PCs provide much needed additional computer resources for her class. I watched them in an ICT lesson using the desktop computers in the ICT suite and the Tablet PCs to design and create pages for a school website. The activity was replicated on both types of computer.

The children worked in pairs and had previously created a paper design/notes for their chosen page. Their page was then worked on in Publisher. The children chose to use the Tablet PCs in a fairly vertical position, resting them on metal stands – this, they said, made it easier to see the screen. To enter text, three of the four pairs used the onscreen keyboard with the pen, which they said was quicker than using the handwriting recognition, as that took longer to correct. They also expressed a preference for the desktop computers as it was easier/quicker to enter text with a physical keyboard.

In design and technology

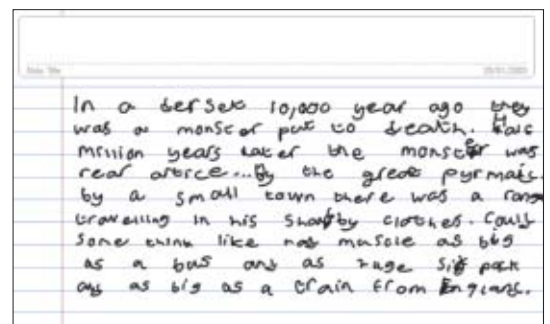
The Tablet PCs were used to create the designs for a slipper using Colour Magic.



As part of SEN provision (SEN and literacy)

One Tablet PC was sited in this class every morning for the use of a child with an IEP. He used it to practise spellings and also used Journal for writing. For example, he performed the same task as the other children, writing a myth and also recording five facts about a god or goddess which had been researched on the internet.

The teacher believed that there was some improvement in both his handwriting and motivation that might be attributable to using the Tablet PC and pen input.



Case study 1

On a field trip

The previous summer a small group of Year 6 children had taken the school's newly acquired Tablet PCs on a school visit to the Isle of Wight. They used their Tablet PCs with the audio recording program Audacity to record their diaries each night. They also used Journal to make notes. The teacher remarked that keeping diaries had become an activity they enjoyed rather than a chore, as is so often the case on school trips! On their return to school they were able to use their sound tracks and notes to compile a multimedia presentation for their parents.

Key lessons learned

- Tablet PCs opened up new ways of working. In particular they could encourage different teaching styles and support different learning styles.
- It took time for staff to acquire the skills to use the Tablet PCs and the confidence to exploit their use in the classroom.
- Teachers did not have time to experiment for themselves, so training sessions incorporating both skills development and ideas for use need to be planned into the school year.
- Charging Tablet PCs' batteries and the locations of wireless network points could affect classroom usage. These needed to be considered early in deployment.
- The role of learning support assistants changed – they needed to gain skills in using the Tablet PCs.
- Tablets could be motivational for teachers as well as for children.
- You needed to think about how to take advantage of the features of Tablet PCs when you were planning.

The staff were enthusiastic about the potential of the Tablet PCs, only wishing they had more of them and more time and opportunity to explore their potential.

Green Lane Infant School

Overview of school

At the time of the case study this infant school in a deprived area of Leicester with wide cultural diversity had 300 pupils, for 95% of whom English was their second language. The school received a very positive inspection report in 2003.

Description of ICT resources

Overall resources

There were 34 PCs, each class having a computer centre with three PCs on the school network. All the teaching staff had a laptop. There was one interactive whiteboard for shared use in the arts studio.

Tablet PCs and associated peripherals

Eight convertible Tablet PCs, all with the original Tablet PC operating system, were available for use by staff or pupils. There were six docking stations and three hardwired data projectors. Part of the school had a wireless network which was used by the Tablet PCs to connect with the school network, the internet and the printer.

Tablet PCs were chosen because they 'offer an extremely powerful multi-sensory learning experience, stimulating different parts of the brain. Pupils can see, hear and touch their work as it progresses, becoming completely absorbed and fascinated in the results of their own actions' (Headteacher, Green Lane, in Toshiba (2004)).

The Tablet PCs were kept in a converted office, and used as a group resource by Years 1 and 2. ICT skills were developed using Revelation Art software which was also available on desktop machines. Tablet PCs were also used during creative writing and for independent exploration of the internet to collect information relating to projects. Gifted and talented children used the Tablet PCs as a selected group withdrawn from class.

Examples of use with Revelation Art

Revelation Art was used with children from Years 1 and 2 both as part of Tablet PC familiarisation and to develop pupils' achievements in art, by carrying out an activity such as painting using physical paints and paper, and then repeating the activity on the Tablet PCs.

I observed the gifted and talented group working with the headteacher using Revelation Art on the Tablet PCs. Given a free choice of tools and subject, the children were quickly at work. They had established favourite tools: some opted to draw with pens and brushes; others selected patterns from a range available. Some of the features they used included colour mixing, using fill or brush to colour in the outlines of Rangoli patterns, the starburst and symmetry tools, and shapes. The children were confident in the use of the menu bars and the various drop-down lists and tool bars, and were not put off by wrong selections.

The children were allowed to print their work to the colour printer, which they did using the standard Windows 'save file' and 'print' options. Most were able to do this unaided.

The same software was available on the desktop PCs and the teachers said the children had quickly transferred their skills to use it with the mouse. This group of children had a good grasp of ICT language and had influenced ICT use in the classrooms by sharing their skills with both the teachers and the other children.

During an afternoon activities lesson I observed a second group working with the classroom assistant to illustrate the story 'The three little pigs'. First the building material for each of the pigs' houses was recapped by the teacher with the whole class, with the aid of physical samples of materials. A variety of activities had been prepared. Four children were chosen to work with the Tablet PCs, which were positioned in slate format ready for use, two to a small table. These children had not used the Tablet PCs much, so they were guided with questions such as: 'Which package should we use?' and 'How do we get the pen?' After the software was opened for use they were asked 'How do we fill in the picture?'



The children chose their own tools. They used the wax crayon tool, which for drawing and colouring-in most closely resembles paper and crayon, or the Cromar tool – a bit like a small sponge-headed lollipop – which results in very loose colour cover, but is good for shading in.

Three of the four were very confident and worked independently, but the fourth sought reassurance from time to time. They all worked quietly for over 20 minutes, with occasional questions for each other and the classroom assistant. They seemed undisturbed by the children in the role-play area and water activity nearby.

Case study 2

Handwriting and handwriting-recognition use by gifted and talented group

A group of eight children from Year 2 was withdrawn two or three times a week to work with the headteacher using the Tablet PCs. These were the first children to use the Tablet PCs in the school. The lessons took place in a narrow room with a workbench along one side and chairs on the other. The children chose either to work with Tablet PCs flat on the bench or sitting with them on their laps. They prepared the Tablet PCs for use themselves with minimal guidance. They showed enthusiasm and engagement in the task, whether demonstrating the range of features available in Revelation Art, exploring web pages, or writing in Journal or Word.

Between case study visits these eight children also carried out the following written activities:

Converting handwriting into text in Word

The children each wrote about whether they liked using Tablet PCs. Their replies were presented in a mixture of fonts and colours, including highlighted text. They included the date in their document. Here are some of the things they wrote:

- I can use the laptop [meaning Tablet PC in laptop mode]
- it is fun and my favourite is Art
- I like the Starburst in Revelation art
- Starburst is my favourite tool
- I like changing the font
- I like to go on the E-mail detectives. I learn about computers and I like to right with the laptop [meaning Tablet PC in laptop mode].

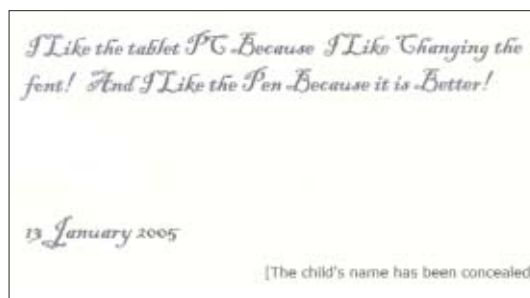
Handwriting in Journal

The children wrote a list. This was saved as their handwriting.

Converting handwriting into text in Word

The children wrote about writing with the pen on the Tablet PCs. Some expressed a preference for using them in 'laptop' mode, which they referred to as 'Laptop(s)', while others preferred using them as a slate, which they referred to as 'Tablet' or 'Tablet PC':

- It can read my writing and when I'm using the Laptops it is hard
- I can use the special pen
- I like using the Tablet because I can write with the pen
- I like to write on the Tablet PC because it is much more fun and the writing pad can read my writing
- I like the Laptop better than the Tablet PC's because it doesn't read my writing very well.



I observed the children were encouraged to use Word with handwriting recognition. They were writing messages to their parents in preparation for sending an email message using Email Detectives. The only difficulty they had was correcting errors. Some deleted the whole word and rewrote it, not always correctly, whereas others used the pen with the onscreen keypad to select and replace letters.

Key lessons learned

- It is important to have a reliable wireless network: there were problems with signal strength, which caused things to crash or malfunction.
- Having Tablet PCs meant that more support was needed – both technical and classroom.
- They needed to plan activities to allow for the fact that the batteries would last only two-and-a-half to three hours, but could be charged very quickly.
- Tablet PCs could be very disruptive in class because all children wanted a go. Using a small room for children withdrawn from the class had better results.
- It was not easy to share the Tablet PCs, as pupils needed to be 'head on' to the screen.
- While the screen displays were good, it helped to work in a dark environment.
- Teachers needed to feel confident and be trained in order to make full use of the Tablet PCs' potential across the curriculum.

St Peter's CE (C) Primary School

Overview of the school

Located on a busy road in the attractive village of Yoxall, the school building – part Victorian, the rest more recent – has four levels. At the time of this case study St Peter's had five classes with about 140 children on roll. The school was part of a small schools cluster group.

Description of ICT resources

Overall resources

St Peter's had four desktop computers in the former ICT room (which had been freed up for other purposes) and two in the library connected to the network. The school had a broadband connection. Two classrooms each had a stand-alone desktop PC. In the Key Stage 1 area there were three more stand-alone desktops. Each teacher and most of the teaching assistants had a personal laptop to connect up to the interactive whiteboards. The ICT co-ordinator was a full-time class teacher and the only technician support was for one day a fortnight. They felt that more technical support was needed.

Tablet PCs and associated peripherals

St Peter's had 16 slate-style Tablet PCs running the original Tablet operating system – 15 for pupil use and one teacher Tablet PC. The Tablet PCs could connect wirelessly to the school's local area network. This class set of Tablet PCs was used on a timetabled basis.

St Peter's also had five interactive whiteboards, which could be used with the Tablet PCs or staff laptops; nine printers, one of which was specifically for use with the Tablet PCs; one scanner; one digital camera; and a charging trolley. Staff could use the teacher Tablet PC at home, but most used their personal laptops for administration and preparation.

Replacing the ICT suite with Tablet PCs

When St Peter's were reviewing their four-year-old ICT suite, they decided to replace it with Tablet PCs. The school decided that changing to Tablet PCs offered a more suitable solution that would be less disruptive to pupil experiences. At the same time it freed up a classroom for other purposes and provided more opportunities for maximising ICT use in an integrated way. Tablet PCs were seen as providing flexibility and support for teaching and learning in line with the way the school was organised, rather than controlling how things could be done.

The school took great care in the advance preparations they made for simultaneously installing new servers, a wireless network and the set of 16 Tablet PCs. They consulted appropriate sources of expertise, employed a reputable firm to supply and

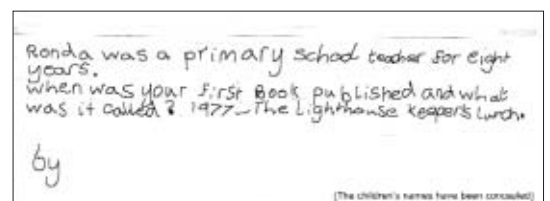
install the new infrastructure and Tablet PCs, and signed up for the highest level of support from their LEA. They were prepared for certain things – for example that logging-on and uploading or downloading video might be slower over a wireless network. Indeed they had been assured that these would be the only difficulties. However, when the new equipment was installed they were disappointed by the high number of technical problems they experienced. It proved difficult to identify the causes of these problems and then to resolve them. Understandably St Peter's felt that these initial problems had damaged staff and pupil confidence with the Tablet PCs. Throughout this period the senior management team (SMT) in the school remained confident that everything would be satisfactorily resolved.

Despite the initial problems, the use of ICT at the school increased following the introduction of the Tablet PCs. The SMT felt that the decision to replace the ICT suite with a set of Tablet PCs had been justified: not only had they freed up desperately needed space, but also the Tablet PCs in the classrooms were used a great deal more than the desktops in the former suite had been. In addition, staff were exploring and developing the pedagogical potential of the Tablet PCs and new infrastructure. In the light of these successes, the SMT were already planning to acquire a further set of Tablet PCs.

Using the Tablet PCs with a mixed Year 1/2 class

A Year 1/2 class teacher, whom we will call John, described how his class had the Tablet PCs in the mornings for one week in every five. During these times he used them in literacy and numeracy whenever possible in order to support and extend the lesson objectives. On one afternoon each week John's class used the Tablet PCs for ICT skills and cross-curricular thematic work.

Using Journal to write up information found on the internet (Year 1/2)

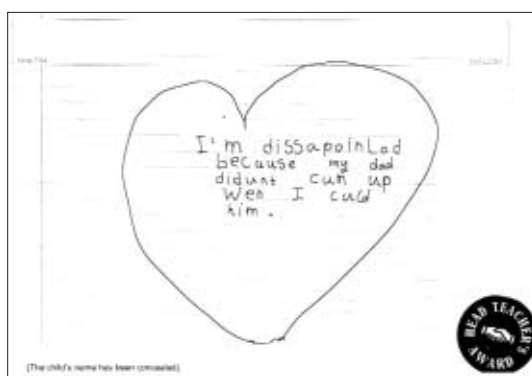


(The children's names have been concealed)

Case study 3

John described Tablet PCs as 'doing all that any computer would' but fitting in better with his classroom management and organisation. He felt that having the Tablet PCs with the printer on the trolley in the classroom worked well, enabling the integration of ICT across the curriculum: "it's all there in the room."

The children sometimes worked in Journal and kept their handwriting as digital ink. For example, when they were working on characters and feelings they used the pen to draw big hearts and then handwrote their feelings inside them. The children enjoyed being able to record their thoughts in this way, and particularly being able to make changes without leaving a mark on the 'paper'.



The children loved using the Tablet PCs and this made them very motivating. John said that this was especially valuable for encouraging reluctant writers in creating ideas for writing.

When writing, the children mostly used the on-screen keyboard as John had found that using handwriting recognition needed 'a bit of getting used to for children at this stage of their writing development'. However, John wanted to develop the use of handwriting recognition as he felt that this was going to be the most valuable aspect of Tablet PC use. Another member of staff who felt that for 'reluctant writers' who found handwriting practice less than exciting, 'getting the computer to recognise your writing would be seen as something of a challenge'.

Children's perspectives on Tablet PCs

In the Year 3/4 class, three children, who wanted to be called Mark, Chloe and Fred, talked about all the things they had used their Tablet PCs for in class, as well as their experiences of using other computers at home and in school. They had all been using the interactive whiteboard and even, sometimes, their teacher's laptop. They liked the Tablet PCs. Chloe said she liked Journal because it was a lot easier to write than use the keyboard as sometimes finding the letters on it [the keyboard] takes longer and slows you down. Mark agreed with her, saying: "you really don't need a keyboard on Journal – it's faster to write than to type ... on Word you have to type." Fred said that he liked the handwriting recognition best: "it transforms your writing but it has to realise what you are doing first," adding that he really liked the Tablet PC "when it worked, but hate it when it goes wrong." Alluding to the serious 'setting-up' problems that the school had been having with the Tablet PCs, wireless networking

and new server, the children commented that they thought it was annoying, just when you were nearly finishing, to be afraid that all your work could go. Chloe said she liked the Tablet PCs better than the ICT suite "because you can carry them around and you can't move computers with wires and the wireless connection is really good." When asked how they would describe a Tablet PC, one of the children said, "a quick definition – a Tablet PC is a little interactive whiteboard." They all said that everyone loved having a go on the interactive whiteboard, adding "so everyone loves having a go on the Tablet PCs."

An example of a mind map in Journal (Year 3)



These children had used the Tablet PCs in a wide range of different curriculum areas, including literacy, numeracy, history, design and technology, and art. Their teacher felt that, when the technology functioned well, the Tablet PCs enabled effective integration of ICT in class and across the curriculum. She felt that, used in this way, the Tablet PCs had a huge impact on the curriculum and in making lessons more successful. The Tablet PCs fitted comfortably on the tables and, because everyone and everything was in their usual place, lessons could be more relaxed.

Key lessons learned

- Having a reliable and efficient infrastructure was expensive, but essential.
- Wireless network access was essential in every classroom and other areas where you wanted to use the Tablet PCs.
- A high level of technical support was vital.
- Battery life was around two hours – not the four hours predicted by the suppliers – which had implications for timetabling, planning and classroom management.
- Having a safe and secure place to keep the Tablet PCs was essential, because they are so portable.
- Additional support in the classroom, for example from a teaching assistant, was valuable in order to help ensure the most effective use of the Tablet PCs.
- Using Tablet PCs instead of an ICT suite had increased the level of use of ICT and enabled it to be embedded across the curriculum.
- Staff commitment was the most important factor.
- Even given the difficulties, the children loved using the Tablet PCs.

St Willibrord's Primary School

Overview of school

At the time of the case study this was an Education Action Zone school, close to major urban renewal projects. There were 220 on roll, including the nursery, and 58% of pupils were eligible for free school meals.

Description of ICT resources

Overall resources

St Willibrord's had an ICT suite of eight PCs, as well as four other PCs for staff and eight for pupils. There were 20 laptops and six Pocket PCs for pupil use. There was wireless networking throughout the school. The ICT suite and each of the Key Stage 2 classrooms had an interactive whiteboard, with two interactive whiteboards in the Key Stage 1 area. There was an ICT club one night per week to support children who did not have access to the internet at home. The ICT facilitator was a full-time higher-level teaching assistant, who provided classroom as well as technical support.

Tablet PCs and associated peripherals

There was a class set of 14 convertible Tablet PCs (with removable keyboards) for pupils and one convertible (twist-style) Tablet PC for staff use. These were stored in an ICT room and used in the classrooms and adjoining areas. The Tablet PCs were running the original Tablet operating system and the only additional software was an office suite. Each class was timetabled to use the Tablet PCs and teachers could arrange for the ICT facilitator to be available for in-class support.

accurate to cope with the transfer to text and children find it frustrating to have to make so many 'corrections.' However, the school still hoped to develop their use of handwriting recognition in the future.

A Year 5 teacher, whom we will call Mary, thought that the Tablet PCs had been excellent in providing increased opportunities for ICT use to all pupils, especially in Key Stage 2, where the wireless connection offered extended and valuable access to a range of more independent research work in all subjects. Mary described how the Year 5 pupils had used their Tablet PCs to research their own choice of 'eminent Victorian' in order to present a class assembly to the school. This had only been possible because, when using the Tablet PCs, "ICT comes to the classroom and the pupils and not the other way around." Mary felt that without the Tablet PCs and the wireless network the opportunities for pupils to become truly independent and confident learners, setting and researching their own questions, would have been curtailed. They also enabled her to run the homework club, which would otherwise not have been possible, and this made an important contribution to equity and to combating the 'digital divide' within the school.

Mary described how the Tablet PCs, with the wireless network, enabled the pupils to "learn in a much greater virtual space," and allowed the whole class to be involved at once in "more hands on learning... more multi-sensory... kinaesthetic learning..." which simultaneously increased their confidence and ICT skills. This combined with the fact that the Tablet PCs were attractive to the children, who were highly motivated to use them.

Facilitating collaboration and a sense of audience

One pupil described how he and his partner had been carrying out research on Alexander Graham Bell. He explained how using the pen was so much easier than moving things around with the 'mouse ball'. Earlier in the lesson he had demonstrated how quickly he and his partner had been able to log on and begin searching for the information they required and how careful they were in checking the key facts on one site with those on a different one. They were very excited and called their teacher to see when they found a site that matched their requirements perfectly...and even went further to give additional relevant information. They 'bookmarked' their site and gave the details to another pair of pupils researching a different person. The teacher commented later on how frequently

"The big advantage of the Tablets [compared with laptops] is their size and portability. They make the management of classroom space much easier. If a table of four children are each using a Tablet there is still room on the table for workbooks etc. The detachable slate on the Tablets is also a useful feature."

ICT facilitator

Developing the use of the Tablet PCs

St Willibrord's obtained their Tablet PCs two years prior to this case study as a result of an Education Action Zone initiative. The school, strongly supported by the parents, saw this as a valuable opportunity to further enrich their use of ICT in teaching and learning. They initially intended to use the Tablet PCs to explore writing and handwriting but, as staff realised the potential of the Tablet PCs when used with the wireless network, their use was extended considerably. Staff also found that the handwriting recognition did not work well, particularly for young children: "it's not sufficiently

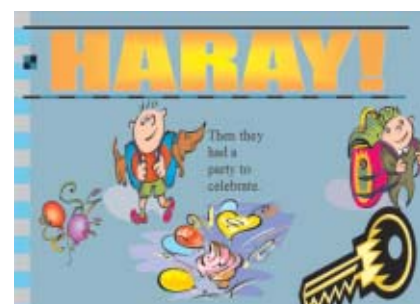
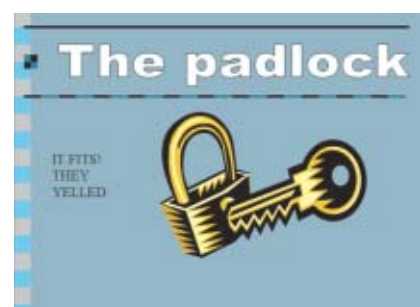
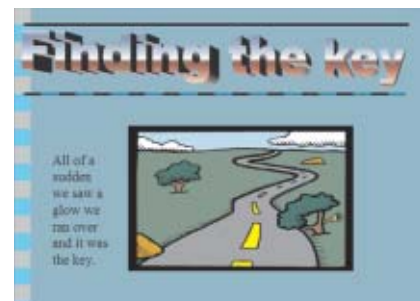
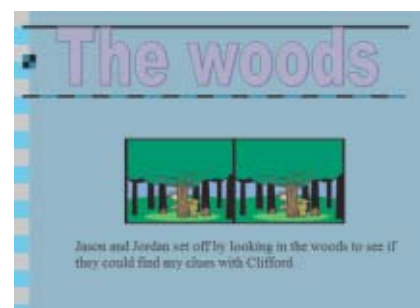
Case study 4

pupils were able to find out much more useful information than she would have anticipated and how beneficial she felt it was that children could collaborate with not only their working partner but with others in a positive way.

The ICT facilitator described how Year 6 pupils had used PowerPoint to prepare 'stories' suitable for younger children. He explained how activities like this provided learning opportunities that helped pupils in developing their understanding of narrative structure and the syntactic and semantic aspects of language. The 'sharing' aspect of this work offered both a real audience and purpose for the composition and an opportunity to develop confidence in presentational skills. It also developed ICT skills in an integrated way and in a meaningful context and, not least, all the participants enjoyed the experience. He felt that the portability of the Tablet PCs with the wireless network, and the ability to use them with a data projector, added a great deal of value to this kind of task and enhanced the experience greatly.

Key lessons learned

- More funding for additional software and peripherals as part of the original Tablet PC provision would have increased the school's ability to make full use of their potential.
- It was important to budget for higher maintenance costs.
- All the ICT equipment (network, server and Tablet PCs, for instance) needed to be compatible, reliable and sufficiently robust for the purposes for which it was intended.
- Training and ICT support were essential for both understanding of the full potential of the Tablet PCs and also developing and sharing professional and pedagogical practices, and this training and support needed to be ongoing.
- The Tablet PCs were much more useful than the Pocket PCs, owing to their versatility and extended functionality.
- The Tablet PCs were very motivating for pupils and had great potential.



Engayne Primary School

Overview of school

At the time of this case study, Engayne was a three-form entry school of 610 pupils, situated in a suburban area of mixed residential housing. The extensive grounds included a playing field and outdoor swimming pool. All classes were mixed ability and the backgrounds of pupils reflected a broad social and ability range. The school was a SCITT provider. Classes were located in three separate buildings and in September 2003 an administrative area (staff room, offices and reception) was added.

Description of ICT resources

Overall resources

Engayne had an ICT development team (associate headteacher, ICT consultant and ICT technician) who met weekly to review and improve the use of the ICT resources. The technician was available for four days a week and the ICT consultant was a full-time member of staff who supported this school and was available to other schools and authorities on a consultancy basis.

Engayne had 32 desktop PCs for staff and 20 for pupil use, plus 10 laptops for each of these groups. There were also two PDAs for staff use. The school had a 2Mbps broadband connection and a wireless local area network, with wireless access points placed around the school – both inside and outside the buildings. Each class and both halls had hardwired data projectors permanently fixed to the ceiling. Each member of staff had a memory stick for personal use, and the school was equipped with 26 printers, two scanners, six digital still cameras and one digital video camera. Most equipment was accessible to both staff and pupils.

Tablet PCs and associated peripherals

Engayne had 88 convertible Tablet PCs: one for all but two members of the teaching staff and 64 for pupils. The pupil Tablet PCs were organised into four sets of approximately fifteen, which were placed strategically around the school. Each set of Tablet PCs was stored on a charging trolley, with each trolley serving five classes. Wireless access points were included in each Tablet PC trolley to provide additional wireless capacity. The software on the Tablet PCs closely matched that available on the other computers in the school, and included an office suite, presentation software for use with a data projector and whiteboard, and a wide range of 'curriculum software'.

The ICT development team

Engayne was formed as a result of an amalgamation and the team felt it was time for a move towards a more integrated and visionary use of ICT at the school. The ICT team saw the introduction of the Tablet PCs as a truly effective way of 'bringing the world to the

pupils'. The senior management team respondent was clear that for her there was "a passion that drove me to realise this dream" underpinning the Tablet PC initiative.

To avoid continually 'playing catch up' in the new school, they also felt it was time for a strategic re-think and for considerable investment. Tablet PCs, they felt, had enough of 'a future model about them' without being too far ahead to be compatible with existing ICT knowledge, confidence and competence. Tablet PC mobility had really strong appeal to them as a multi-site school: 'offering anytime, anywhere type use'. They also had some uncertainties about the suitability of interactive whiteboards for their purposes, but needed this type of functionality. The team stressed the importance to them of doing extensive research and of seeking a range of advice before making procurement decisions.

Tablet PCs were used in every class and for every curriculum area, each class using them on a rota basis for two half days a week.

In addition to their extensive fact finding, the team planned and piloted an 'action research' approach in their phased introduction stage. A number of models of organising and managing the Tablet PCs were trialled using 'champions', members of staff who were willing to act in this role, located in various parts of the building, in different phases and different curriculum areas. Staff views were collected on the test strategies before the school settled on one approach. The ICT development team recognised that as major change was anticipated, which would have an impact on practice right across the school, there was need for a planned approach to staff training. Inset, 'phased over time so no one felt overloaded with technology', was therefore dedicated to exploring the Tablet PCs and their potential.

At Engayne they felt that careful preparation had got them the ICT provision that really suited their needs and that offered everyone much greater opportunity to use technology. For teachers this was in all aspects of their professional life, but especially in teaching and learning. For pupils it meant far greater access in terms of the physical and virtual spaces in which they could learn, and more time to develop their ICT skills in the meaningful context of a full range of curriculum areas.

Case study 5

Tablet PC use in a Year 6 class

A Year 6 teacher and subject leader, whom we will call David, used his personal Tablet PC extensively for planning, preparation and in almost every lesson for teaching. With the pupils he used a class set of Tablet PCs during the two timetabled sessions each week to support learning in every subject area, including PE. His class were also eager to have any additional time on the Tablet PCs, should it become available unexpectedly. David commented that he was particularly impressed at how rapidly the pupils' ICT skills were developing in response to there being so much more time for embedded, implicit teaching – saying that he thought there was a danger of the programmes of study for ICT in Year 6 becoming redundant.

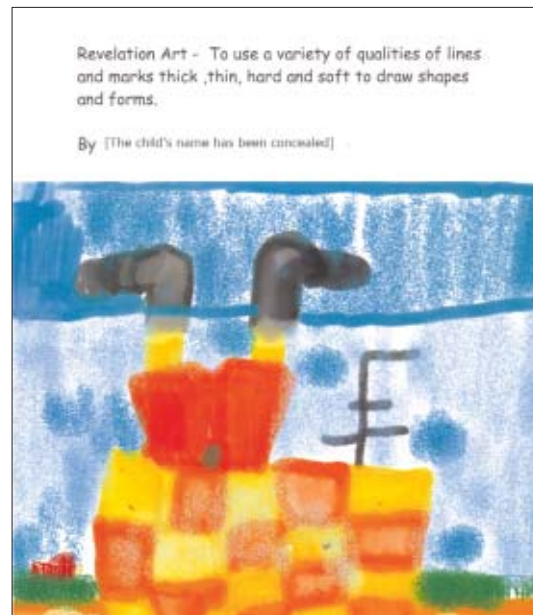
“It’s so much easier for me to prepare on my Tablet and give the children access either on their own Tablets or our whiteboard ... I find we are watching more things that are live and so much more engaging ... there are more opportunities for pupils to use more varied forms of research ... and have access to rich and varied resources ... they learn in more collaborative and more visual ways... .”

Year 6 teacher

David felt pupils were 100% engrossed in what they were doing in lessons where they used the Tablet PCs and that these made a significant contribution to motivation and self-esteem. He produced a portfolio of work, which showed how Year 6 pupils had used the Tablet PCs over a few days. They used the Tablet PCs in literacy for web research on authors, and then to enter the information into a prepared Publisher template and finally to make book jackets as part of their work on biographies. They also used a spreadsheet to record results in science and to work on test scores, turning the data into a bar graph and formatting the graph. Their very first exploration of the Tablet PCs had involved using the pen to create art work with Revelation Art. They had also watched video clips in history, PE and RE and had fun (and valuable practice too) playing maths games.

With the convertible Tablet PCs that Engayne had, pupils used the pen and keyboard intuitively and, although David might have suggested using one or the other, pupils chose whichever best fitted the task. Having both was a valuable asset. David felt that the pen was engaging and the wireless web link was invaluable. He had anticipated that the Tablet PCs would be used extensively in science and English but had found them valuable everywhere, especially in history, geography and RE.

Santa got stuck up the chimney (Year 3)



As one of the 'champions' and as a subject leader, David led sessions for colleagues on the Inset days. He took them through some familiar software and some new applications for different age groups – modelling the various stages in the processes of accessing, implementing, customising and saving activities on the pupil and staff workspaces. Advice, suggestions and new ideas emerged and were incorporated as everyone found their way around their own Tablet PC. They saw the sharing of experience of 'what goes wrong and how to fix it' as a significant part of the implementation process, which complemented the 'more professional' sharing of teaching strategies and curriculum applications. They were considering getting rid of the ICT suite and distributing its resources in clusters around the school.

Key lessons learned

- Careful research was essential; this needed to include looking into the type of Tablet PC, adequate wireless networking, compatible server space and compatible software.
- Procurement of adequate peripherals was important to make use easy and flexible.
- Planned implementation, careful phasing in of new equipment, trialling and reporting back of alternative management and organisation systems worked well.
- Staff training in software awareness, curriculum application, the pedagogy of Tablet PCs and presentation technologies was very important.
- Adequate and ongoing funding for initial purchase and subsequent maintenance (battery replacement, repairs and so on) was vital.
- A dedicated, named project manager from the provider and a well worked out service agreement was invaluable.
- Availability of skilled technical support was crucial.
- Senior management support was very important.

St Francis RC Primary School

Overview of school

St Francis RC Primary School is in a multi-ethnic inner-city area. At the time of the case study it had 320 children, including those in the nursery. Tablet PCs were chosen for use solely by children in the Classroom of the Future (Year 5) with the aim of creating a 'paperless classroom'.

Description of ICT resources

Overall resources

The school was well equipped with ICT resources. It had two ICT suites, the more recent of which had 30 networked PCs in a modern laboratory/teaching area. Each classroom had a networked PC and there was also at least one stand-alone PC in every classroom. Each teacher had a laptop and there were eight interactive whiteboards. Each ICT suite had two printers.

Tablet PCs and associated peripherals

For the Classroom of the Future, the school bought 33 slate-style Tablet PCs and USB keyboards; these connected via the wireless network to the school network and the internet. There were three printers in the Classroom of the Future. When not in use, the Tablet PCs were kept on charging trolleys, but these were not left on overnight. In the morning the teaching assistant or teacher turned the power on. Monitors logged the Tablet PCs onto the school network. Work was saved to folders on the server.

The Tablet PCs were used:

- by the 28 children in the Classroom of the Future
- for approximately 75% of the available time
- for all curriculum subjects except maths (for which children were divided into sets), especially for researching and recording
- in the various areas within the structure of the Classroom of the Future and the area around it (but not in the rest of the school or at home)
- with external keyboards for extended writing, which was approximately 30% of the time when they were in use
- with pens, using handwriting or the onscreen keyboard (approximately 70% of the time when they were in use).

Researching using a database

The class were studying Greek gods and goddesses. They had been using Information Magic and a database of Greek gods. The teacher used the database displayed on the interactive whiteboard and they recapped the terminology and meanings of the

database attributes. This was followed by searching on specific fields and combinations of fields to find specific records.



The children had two electronic worksheets on their Tablet PCs to complete and after this they worked on a PowerPoint presentation. Children worked in groups of two or three.

There were various logistical tasks to be done as part of this, such as saving work to the correct area and opening the second worksheet and renaming it by putting their own name at the beginning of the existing one. Most children had no problem with this, although one child with an IEP needed support.

A few children needed to work on the docking stations as their Tablet PCs had flat batteries or network connection problems. Other groups moved to separate areas within the building to work, and all were quickly on task and stayed focused until it was time to leave for swimming.

Between my two visits there were many other examples of use of the Tablet PCs. Here is a selection from different subject areas:

- English – writing in Journal – listing homophones
- English – using Word – finishing off a fable and listening to the Tablet PC reading it out to them before editing
- maths group – internet – interactive maths program
- science – internet – BBC interactive science quiz and material-sorting activity
- history – internet – researching battle of Marathon
- history – Publisher – writing newspaper article on battle of Marathon.

Case study 6

Children talking about the Tablet PCs

Children were able to select any work they needed to complete. I sat with a girl, whom we will call Helen, and a boy, whom we will call Henry. Helen and Henry had created portfolios of work to illustrate the ways in which they used the Tablet PCs. They continued working on individual presentations while they talked to me about the Tablet PCs and showed me the work in their portfolios.

How do you feel about using the Tablet PCs?

- When you use the pens on Tablets it's better than on paper as your hand gets less tired.
- I like using them, but it's a bit slower than a [desktop] PC for PowerPoint, internet and Publisher, and sometimes they don't work.

How do they compare with a desktop PC?

- They are smaller and you use a pen.
- It's easier to use the drawing tool in Word.
- It's better for drawing than a PC – when you handle the mouse it's much harder to control.
- If you draw on paper it's easier and then you know where the colours are. It's harder on the Tablets. Also on paper it's easier to draw any shape.
- The double click on the PC doesn't make bad things happen, not like on the Tablets.

And what about writing with a Tablet PC?

- Sometimes for notes we use the pen.
- In Word we use the [USB] keyboard if it's a long piece of work. If it's short we just use the pen.
- With handwriting recognition sometimes the word comes out wrong.
- With the [onscreen] keypad we have to find where the letter is and this is slower.

What if there were only eight Tablet PCs for the class?

- Not as good, as we'd need to share.
- Writing in books makes me tired.
- I don't think it would be as good if we didn't have [our own] Tablets.

Both children selected PowerPoint presentations from their portfolio as the work they liked best. They had each researched on the internet for material, which they had written about in their own words.

Helen had found images on the internet and downloaded them to her pictures file. Henry had found pictures inside Office. Both of them had experimented with colours for background and font. Henry had included some background sounds.

Key lessons learned

- A reliable wireless network connection was important.
- Support requirements increased, particularly at the start.
- Planning the management of the logistics was important (for example charging the batteries and where children saved their work).
- Bigger screens would make it easier to see the display.
- The Tablet PCs improved motivation, concentration and communication skills.
- It was important to utilise the system fully – for example getting children to save more of their work to build up a profile, which was useful for parents' evenings and for monitoring progress.
- Electronic marking was very effective.

Horse Nut

The horse nut is dispersed by animals.

I think that it's dispersed in this way because it has got spikes on it, so it hooks onto the animals feet and the animal just keeps on walking.



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Wylde Green Primary School

Overview of school

Wylde Green Primary, in the north of Birmingham, was built in 1840. At the time of the case study, in early 2005, considerable building work was going on. Each year the school could admit 60 children into reception and there were six infant classes and eight junior classes. The school had 360 full-time pupils from reception to Year 6. The proportion of boys and girls was similar, and approximately 80% were from a white ethnic background, with the rest coming from a wide variety of backgrounds, but with no single group predominating. Some 15% were entitled to free school dinners and 11% had 'a significant learning need'.

Description of ICT resources

Overall resources

The school had an ICT suite with 15 desktop PCs and an interactive whiteboard. There were a further 21 desktop PCs for pupil use in the classrooms – two in each of the Year 5 and 6 classrooms and the SEN room, and one in each of the other classrooms. This gave the school a below-average ratio of about one computer to 10 pupils. The school had a 2Mbps connection to the internet via the Birmingham Grid for Learning. Most classrooms had interactive whiteboards fitted. Years 3 and 4 were in temporary accommodation during the building work (due for completion in June 2005), but will have interactive whiteboards in their new rooms. Six laptops were available for staff use. One stand-alone PC was available for DVD production. The school had an ICT technician whom they called on as and when needed (there were no set hours per week for technical support).

have wireless networking and was unable to connect the Tablet PCs to the school network in the classrooms where they were used, so no access to the internet was available via the Tablet PCs.

Each Tuesday for seven weeks two ICT technicians from Bishop Vesey's Grammar School delivered 31 Tablet PCs to Wylde Green Primary School and stayed with the machines to support the two staff in the school. The two Year 6 classes in Wylde Green used the machines. Prior to the loan period the pupils had no experience of using Tablet PCs, although they all had experience of using desktop PCs and some had used laptops.

The use of the Tablet PCs was broadly similar in each of the two classes. The pupils stayed in their own classroom and the machines were brought to them. The class teacher had support from the two technicians from Bishop Vesey's Grammar School and a student who was on teaching practice at the time. For the first three sessions each child was given a Tablet PC, while in the final four sessions pupils shared the Tablet PCs one between two, to foster and enable collaboration on their projects.

Familiarisation with the Tablet PCs

The aim of the first session was to introduce the pupils to the Tablet PCs and how to use them. Initially the pupils were allowed to play with three of the PowerToys applications – Maze Game, Puzzle Game and Tic Tac Toe. The objective of these activities was to familiarise the pupils with the use of the Tablet PC's pen for opening programs and interacting with them. The second half of the session made use of Journal and was aimed at familiarising pupils with the use of handwriting in digital ink on the Tablet PC, and then converting their handwriting to text.

The pupils were very quick at familiarising themselves with the use of the pen and showed high levels of motivation and enjoyment with the exercises. When

"The children enjoyed using the Tablets so much that they really did not want to be absent on a Tuesday."

Class teacher

Tablet PCs

The machines detailed below were loaned to the school by Bishop Vesey's Grammar School for one morning a week for half a term. Bishop Vesey's is a Language College and part of its role is to support its feeder primary schools. This loan included support from two technicians usually based at Bishop Vesey's. Wylde Green were loaned 31 slate Tablet PCs (without keyboards) running Tablet 2005. The software installed on these machines included Office 2000, Kar2ouche, Tablet PC PowerToys and a range of other software suitable for secondary schools. Wylde Green did not

Case study 7

the children were interviewed, they remarked that they found the pen easy to use, some saying it was as easy to use as a normal pen. Others, however, noted difficulties of control – staying on the line when writing in Journal and getting the angle correct on the pen. Some children liked the fact that they could put the Tablet PC on their knees and write on it. However, some found that to read their writing they had to stop and pick up the Tablet PC.

Using a spreadsheet in maths and science

The second and third sessions had aims relating to the maths and science curriculum. A spreadsheet was used on the Tablet PCs to create graphs using data from a previous science lesson. Both classes had previously used a spreadsheet on desktop PCs. Using the data projector connected to a Tablet PC, the teacher first reminded the class how to use a spreadsheet and instructed them how to use the onscreen keyboard. They then opened a spreadsheet on their own machines, entered data, and chose the appropriate type of graph to display their results. The third session was similar to the previous session in as much as the children had to use a spreadsheet to enter their own data and then create a pie chart to show their results.

Most of the children appeared to cope with the onscreen keyboard for the data entry, but two pupils in one of the sessions realised they could use handwriting recognition for entering numbers and text and shared this with the rest of the class. A few pupils had problems with using the pen for highlighting the cells to be graphed. When the pupils were interviewed, several commented that they thought the letters and numbers on the onscreen keyboard were very small, and also they were never sure that they had actually selected a letter – “A beep each time you choose a letter would be good.”

Using the Tablet PCs to support literacy

The final four lessons made use of Kar2ouche (role-playing software) from Immersive Education. The context used was Macbeth and the version used was marketed for Key Stages 3–5 (ages 11–18). The pupils had never used Kar2ouche before, but they were studying Macbeth, so it seemed appropriate for them even though they were at the lower end of the age range for which it was intended. The pupils were initially introduced to the program using a Tablet PC and a data projector. They were then asked to produce a storyboard for a short scene from the play. The pupils used the pen to navigate, and the pen with onscreen keyboard to enter text. Neither of these processes caused any great difficulty. However, some of the pupils found the actual task rather difficult and one pupil with a special needs statement started to make up her own story using the characters from Macbeth. The class teacher took on board this idea and allowed the pupils to create their own stories with the characters, rather than reproducing Macbeth. The children used sound files and also recorded their own voices for the characters using the audio-recording facility on the Tablet PCs. The pupils then shared their stories with the class using the Tablet PCs connected to the data projector.

Key lessons learned

- This form of co-operation between a secondary school and one of its feeder primary schools was very valuable, not least because it gave the primary the opportunity to ‘try before you buy’.
- The support provided by Bishop Vesey’s Grammar School was essential for the success of the project. This support included moving the machines between classrooms and ensuring that the machines were fully charged at the start of the day. Ancillary support for these tasks is essential.
- The children generally found the use of the Tablet PCs easy, enjoyable and motivational.

Queensbury School

Overview of school

Situated in the North East of Birmingham, Queensbury School is a locally managed secondary school for pupils with moderate learning difficulties. At the time of the case study the school had provision for 240 pupils, with 30 students in Years 12 and 13. As a special school, its class sizes were quite small, with an average of 15 pupils per class. Some subjects were blocked, so four subjects were taught to three classes – reducing class sizes to 10. The school had subject classrooms for the core and foundation subjects of the National Curriculum, including specialist teaching areas for design and technology, science and life skills. It also had its own playing field, a recently refurbished library and sixth-form block with teaching rooms and a self-contained flat for independence training, and a speech and language room.

Description of ICT resources

Overall resources

Queensbury had a hardwired curriculum network with at least two network points and two networked PCs in each classroom. There were two computer suites – one with 11 and another with 16 machines. For pupil use this gave a total of 69 desktop PCs, most of which ran Windows XP Pro. All desktop machines had access to the internet via a 2Mbps link to the Birmingham Grid for Learning. Five classrooms were equipped with interactive whiteboards, and six with data projectors. All students had a double lesson of ICT in an ICT suite each week. Fifteen teachers had laptops running Windows XP Pro. The ICT co-ordinator and a part-time technician (three days per week) provided technical support.

school's local area network, and the Tablet PCs were not connected to the local area network or the internet. Each Tablet PC ran the original Tablet PC operating system and an office suite. The only other non-standard software added to the machines was Wordshark from White Space. As and when appropriate the teacher Tablet PC was used with a data projector, to which it was connected wirelessly.

During the two years that the Tablet PCs had been in use at Queensbury they were used in a variety of different subjects and modes, two of which we describe briefly below. One of the Tablet PCs was on long-term loan to a student who had motor control problems (hand tremors). Use of the pen and Journal allowed her to write on the Tablet PC and then convert her writing to text.

Improving literacy

Many of the students at Queensbury had difficulties with literacy, which had an impact across all areas of the curriculum. Indeed all but two of the Year 9 students (aged 13–14) who took part in the 'experiment' described here did not have reading ages, as the tests do not recognise reading ages under six. These students also tended to have a poor self-image and lacked confidence as they saw elements of their work as inferior to that of their peers. The 12 students were divided into two groups with similar standards of literacy, and members of one group were each loaned a Tablet PC, while members of the other were each loaned a laptop. This was to enable a comparison of the two mobile technologies, as well as an evaluation of the potential of the Tablet PCs. Parents were written to, as the pupils would be taking the hardware home, and they also came into the school to see the pupils using the equipment before taking it home.

“When I was first given it [the Tablet PC] I took it home and just played with. It was really easy to use. I was surprised how you could do everything on it that you can do with a real computer.”

Year 11 student

Tablet PCs and associated peripherals

As part of Birmingham LEA's Anytime Anywhere Learning project, the school received:

- one slate Tablet PC with external keyboard and USB mouse
- 10 slate Tablet PCs without keyboards.

Queensbury did not have wireless access to the

Case study 8

Unfortunately, the parents of two students did not want their children to take the machines home, as they envisaged family arguments over its use. Another set of parents decided after two weeks that they did not want the equipment at home owing to disagreements between the children in the family.

Wordshark software combines computer games with the task of learning to read and spell. It has 36 different games, which use sound, graphics and text to teach and reinforce word recognition and spelling. Wordshark comes with a number of wordlists but the teacher can add others. Once the teacher has chosen the wordlist, the pupils can choose the game to play with the particular wordlist. Students were expected to use at least two games with each wordlist (see below). The program also has a report area, where the teacher can see what games the students have played and what mistakes they made.



Wordshark image © Copyright White Space

The ICT co-ordinator, who was also the form teacher for the pupils involved in the project, worked closely with the Head of English who used the equipment in some of her lessons. The ICT co-ordinator supported the students in the selection of wordlists, encouraged the students, and tested their reading abilities. Once the project had started and pupils were familiar with the software, they mainly used the Tablet PCs at home. Registration periods and short meetings between the form tutor and individual pupils were used to monitor progress and discuss concerns.

The results of this project, though obviously not statistically significant or able to be generalised, showed increased reading ages for eight of the 12 pupils. Of the four who did not improve, three were those who did not take the equipment home. More interesting was the pupils' reactions to the technology. All students were generally positive and motivated towards the use of the equipment. The students showed a sense of pride when they talked about how they showed members of their family how to use it.

Interesting comparisons between Tablet PCs and laptops emerged. The students using the Tablet PCs found the pen far easier to use than the touch pad on a laptop. Observations showed greater engagement with the Tablet PCs, with the students 'wrapped around them' and using them 'as a more personal item'. The Tablet PC users also seemed keener to show what they had done, perhaps owing to the greater mobility of the Tablet PC. The Tablet PCs proved robust and students could easily slip them into their own bags.

Using Tablet PCs in art

A group of Year 11 students had just started using Tablet PCs to support their work in art lessons. As in the project described above, to allow them to continue their work away from the school some of the students had been allocated machines that they could take home. No special software was purchased for this work: the students used Paint and Journal as supplied with the machines. The students used the facilities available to them effectively to produce work showing perspective. They found it easier to draw the guidelines for perspective using the Tablet PC and pen than using paper with a ruler and pencil. Indeed the use of the pen for drawing was seen as a positive advantage over both the touch pad on a laptop and the mouse on a desktop PC. The use of the Tablet PC also allowed students to experiment, as they thought of the work as more provisional than on paper; they could experiment with colour and, if they didn't like the result, could erase it. The use of the Tablet PCs definitely motivated the students and raised their self-esteem; they became keen to show their work to their peers and staff.



Key lessons learned

- The Tablet PCs were robust and easy for the students to carry to and from school in a way that did not attract unwanted attention.
- Even though a wireless network would have been an advantage, the Tablet PCs were used effectively without this facility.
- The Tablet PCs in this school did not have keyboards, and though this limited their utility in some respects it meant that the Tablet-specific facilities were used.
- The pen appeared to be extremely easy to use in most respects – it was easier to use than either the touch pad on most laptops or the mouse with desktops.
- Students using the Tablet PCs seemed to have greater focus on the tasks set and closer involvement in them.

Invicta Grammar School

Overview of school

Invicta Grammar School is situated on a five-hectare site on the edge of Maidstone, Kent. At the time of the case study it had 1,275 pupils on roll. A new £2.1-million block is due to open during 2005. The school maintains a high profile with strong university and business links.

Description of ICT resources

Overall resources

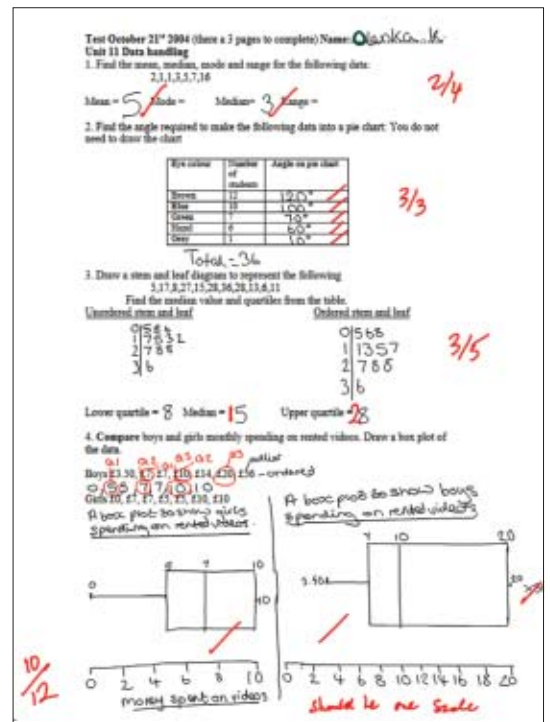
Wireless networking was available throughout the site, providing access for students and staff to 733 computers, of which 480 were portable. The school's eight servers supported a management information system encompassing a student database and finance software, as well as providing email and internet access. Students and teachers could also access the network from home.

Tablet PCs and associated peripherals

The school had three types of Tablet PC: convertibles with detachable keyboards running the original Tablet PC operating system; convertibles with twist/pivot-type keyboards running Tablet 2005; and slates running a mixture of the original Tablet PC operating system and Tablet 2005. Staff mainly used the convertibles, while 180 students in Year 8 used the slates. Most of these machines were purchased in 2003. Data projectors were available in most classrooms to link with Tablet PCs or laptops, and memory sticks were widely used by students and staff. Tablet PCs with a data projector were seen to address the need for whole-class presentation, as an alternative to interactive whiteboards. The level of technical support was increased so that it was readily available throughout the school day. The early models used proved not to be robust and screen damage predominated, but recent models were more reliable. The school's preference was for the 'convertible' design, which they felt offered greater versatility. However, the greater cost of convertibles over slates and Tablet PCs over laptops was a major barrier.

Using Tablet PCs in maths

In this Year 8 statistics lesson, the teacher used an 'electronic worksheet' to provide practice in measures of average. This was one of a sequence of lessons on this topic. The problem sheet was also used as part of a test set as homework and later marked by the teacher. The students wrote their responses on the sheet by hand, using the Tablet PC pen, and the teacher marked them in the same way, with handwritten annotations.



"We decided to purchase laptops for our current Year 7. This was due to price and weight. If there was a similar lightweight Tablet for the same cost, this would be my preferred option as they are more versatile."

Deputy Head and Director of ICT Strategy

The school was also investigating the use of wireless data projectors, which would enable greater student Tablet PC interaction in whole-class settings.

Case study 9

A familiar element of whole-class maths teaching is working through examples of this kind with a class, usually using a presentation device such as an OHP, whiteboard or even a chalkboard. The school used this same approach but with the Tablet PC and incorporated its use in lesson planning.

Year 7 SOW 2008

Unit 1 Directed numbers and Graphs

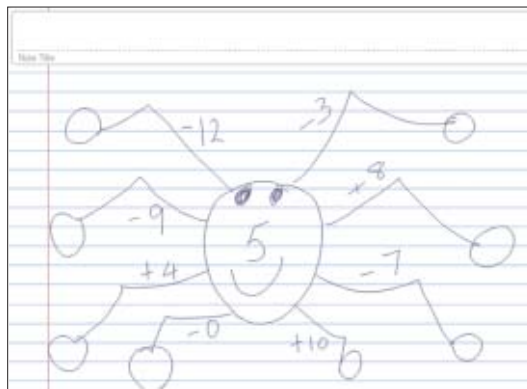
Lesson 1 Learning Objectives Use $<$ & $>$ signs, plot coordinates in 4 quadrants

Mathematical Language
Coordinates Quadrant Axis Axes Origin Positive Negative

Warm up suggestion
Ask most students to write a number between 0 and 15 on their Tablet – taking up the whole screen. Assign $=$, $<$ & $>$ to 3 students. Ask students to come to the front in pairs and decide which of the symbols could go between their numbers.

Main Activity
Use the coordinate grid, x & y axes to plot some points to check 'along and up' using projector or Tablets. Discuss labeling of x and y axes. All students to complete Q2, Theme park and Q3, x & y axes. Use a blank 4-quadrant grid, x & y axes to label and number from high positive down to zero. Ask what to do next. Discuss and use answers as necessary to label all 4 quadrants. Mention that all numbers come out of the centre, they originate there, the origin. All students to complete Q2, Theme park and Q3, x & y axes. Q2 & 3 is more challenging and would be useful extension work.

The Tablet PC pen enabled the teacher to easily modify what was being taught, in the light of students' progress during the lesson. The technology allowed the teacher to discuss examples of classwork with a group and incorporate agreed comments on the assignment page, which individual students could then work on further. In an additional activity, using the Tablet PC and data projector like an interactive whiteboard, the teacher developed simple number quizzes with the class.



PMCC - a worked example

51

In a science experiment a student dropped a ball on to the ground from a height of 2 metres and measured the height x metres, to which it bounced. The experiment was repeated to give 10 pairs of results. The student chose values of x which increased in steps of exactly 0.15 metres. The results of the experiment are given in the table below.

x	0.15	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50
y	0.11	0.17	0.23	0.30	0.40	0.54	0.67	0.73	0.84	0.95

(i) Calculate the product moment correlation coefficient between x and y .

$$S_{xx} = \sum x_i^2 - \frac{1}{n} (\sum x_i)^2 = 20.0425 - \frac{1}{10} \times 18.75^2 = 5.15625$$

$$S_{yy} = \sum y_i^2 - \frac{1}{n} (\sum y_i)^2 = 3.1895 - \frac{1}{10} \times 5.103^2 = 0.65921$$

$$S_{xy} = \sum x_i y_i - \frac{1}{n} \sum x_i \sum y_i = 9.7575 - \frac{1}{10} \times 18.75 \times 5.103 = 1.94125$$

Again following a whole-class introduction and discussion, during which the teacher annotated and modified the shared resource, students then worked individually on that modified material. This approach was especially useful in being able to represent mathematical notation easily.

"The Tablet PC is particularly useful in subjects like maths and science where the use of a pen has considerable advantages over a mouse. Diagrams can be annotated more easily. Templates can be filled in which saves the students time in copying diagrams. It is possible to insert whole past papers into Journal which students can then directly work on. The technology allows accelerated and more independent learning."

Deputy Head

The school also created its own video teaching sequences which were intended for revision or in situations where a student had missed a key lesson. These could be downloaded from the network by students.

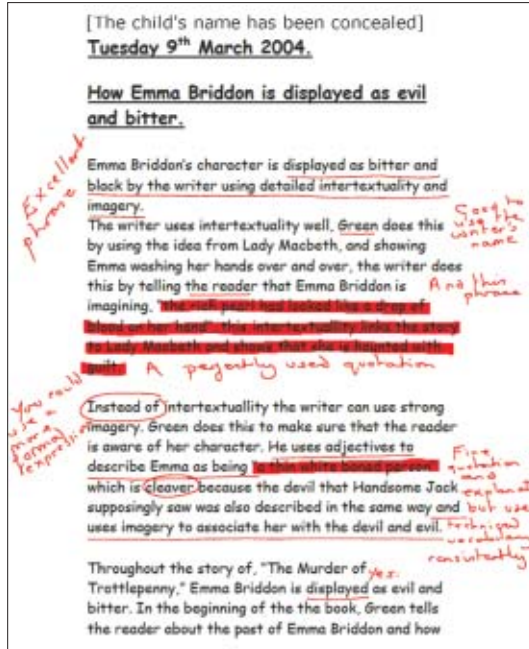
"If we were starting to introduce Tablet PCs again we would begin more modestly, with a phased introduction, perhaps issuing to one group and then when established increasing the number of groups using them. This allows the process to be more easily managed and supported."

Deputy Head

Case study 9

A student perspective

Teachers used Tablet PCs for registration and to update student information at any time across the school site. A common feature of practice at the school was the use of Tablet PCs to annotate students' work. For example a teacher could provide a commentary on a student's critical writing, using the pen to add highlighting and margin notes to the text.



A Year 8 student, whom we will call Sarah, used a slate-style Tablet PC with a USB keyboard. She took it everywhere, and was enthusiastic about it, saying:

"I like the Tablet PC because it is lightweight and so easy to carry around. I enjoy using it. I can take it out of school and plug it into my computer at home. The only difficulty I had was when I lost a lot of work because of a computer virus problem. This taught me to backup files more regularly on the school network which I now always do more frequently."

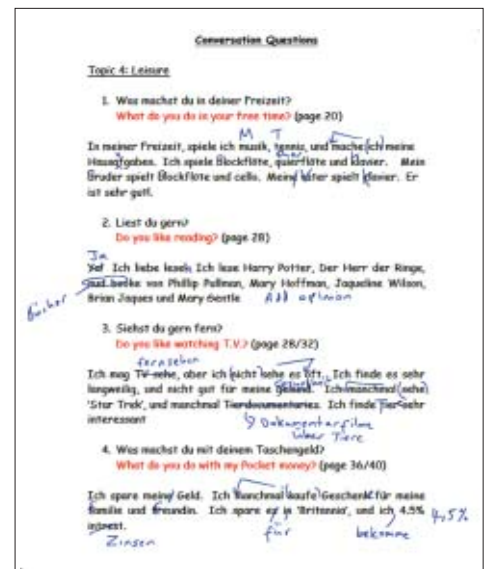
Sarah explained that her coursework regularly required the use of ICT, and provided examples from the previous couple of weeks, which principally involved processing text using Word and Journal. In science, following a whole-class discussion, she first downloaded teaching notes from the school network into Journal. The teacher developed the topic by setting additional questions. Further text-based work had included an evaluation of rock-and-roll music, a study of tourism in Kenya in geography, a case study of women priests in the Church of England in RE, a report on public sanitation in the eighteenth century in history and an essay on 'A Christmas to remember' in English. Much of this work could have been written on a conventional laptop computer, although the use of Journal provided extra features. Additional investigative work set by the teacher also involved the use of the internet to access outside information sources, which Sarah easily achieved using the wireless network.

In modern languages Sarah made use of the pen to include drawings and mind maps in the text.



"The nice thing here is being able to use the features of Word to write in Spanish. Using the Tablet pen it's easy to add diagrams into the text. This is much better than using a mouse."

In German lessons, a similar approach was adopted, making use of the pen to annotate work on improving conversation, with handwritten corrections, reminders and other notes.



"Using the Tablet means I can easily find work I did some time ago and revise or make any changes. It also means I don't have to carry too many books around the school!"

Key lessons learned

- Additional technical support was required to sustain the use of the Tablet PCs.
- Early models proved not to be robust.
- The setting-up process took a considerable time to ensure that the appropriate 'image' was installed.
- Using Tablet PCs, teachers and students were able to add handwritten notes, pictures and diagrams to text which made assignments more lively and interesting. This proved to be a popular feature.

Cornwallis Technology College

Overview of school

The Cornwallis Technology College occupies a site of approximately 40 acres on the outskirts of Maidstone, Kent. At the time of this case study it was a large, non-selective 11–18 high school with over 1,600 pupils.

Description of ICT resources

The college maintained a high profile nationally in its use of ICT in teaching and learning through well developed partnerships with major IT companies, resulting in regular participation in research and leading-edge projects. An evolving ICT strategy was intended to promote an environment of independent learning, with teachers adopting a facilitating role. Where students had a strength in ICT in a particular area, they were encouraged to use it and become 'experts', providing help for their classmates.

Anytime, anywhere access was provided via wireless networking, available throughout the site and supporting the college's 800 computers, 300 of which were arranged in clusters in 15 areas. The remainder were laptops or Tablet PCs.

operating system. Students in two Year 7 classes were each provided with a Tablet PC which they could choose to take home or leave in school. Class sets of Tablet PCs were provided for use in maths, English, science, modern foreign languages, history, geography and RE. The student Tablet PCs were all slates running the original Tablet PC operating system and with either 10.4" or 12.1" screens. Technical support, increased to take account of Tablet PC needs, was available at all times during the working day.

Using Tablet PCs in science

A Year 10 class of 20 students were studying the topic 'Being healthy', which was planned over a sequence of lessons. These lessons took place in a traditional science classroom using six large square tables with electrics centrally positioned. These power supplies proved useful to support the Tablet PCs for each student, avoiding any 'battery life' problems. Since these Tablet PCs had no keyboards, all text entry took place using the pen and the onscreen keyboard. The teacher used a data projector linked to a convertible Tablet PC to introduce the topic. Sessions took place in a darkened room, so that the Tablet PCs' screens were easily visible.

After some core teaching had taken place, students were asked to demonstrate their understanding of the topic, using mainly text processing, desktop publishing, presentation and animation software on the Tablet PCs. For example, using PowerPoint, they developed an electronic exercise book in which they entered their findings. This contained some teacher-generated material which included questions, as well as 'writing frames' into which students could add their commentaries. The students used digital ink, handwriting on the slides with the Tablet PC pens, and creating drawings and annotations.

The next task required them to investigate the respiratory system and the links between exercise and keeping fit. They were provided with an 'e-book', each page of which set tasks such as annotating, drawing a diagram, labelling, taking notes electronically or using a prepared animation sequence (from a USB memory stick).

"It is often the case that adults looking at the Tablets will ask why not use laptop or paper instead of the Tablet when the task appears to be a trivial one and the Tablet technology is not used to its full potential, eg annotating what could essentially be a paper-based task. What is important here is to understand that the Tablets allow the pupils a fresh start with their learning. A pupil may have failed with paper technologies and more paper-based activities repeat the failure. The Tablet allows a new beginning where previous patterns of behaviour and learning can be broken. Motivation thus increases, behaviour improves, and more children are actively engaged in the learning process."

Advanced Skills Teacher/ICT Project Manager

Tablet PCs and associated peripherals

The college had been using Tablet PCs since October 2002, with the main purchases taking place in the summer of 2003. They identified portable technology as being a significant component of their strategy of 'Putting Learners First'. All staff were allocated a convertible Tablet PC running the original Tablet PC



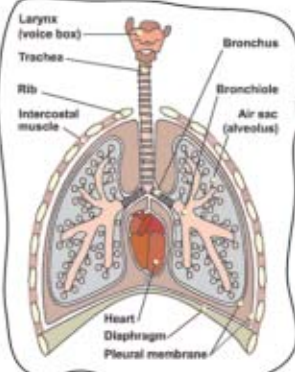
Case study 10

Keeping fit

Aim:- understand how fitness and exercise keep you fit

- What is respiration?
Write the equation for respiration?
- What happens to you breathing and heart rate when exercising?
- Design an experiment to test your answer?

➤ Use the **writing frame** on your USB stick – write on the page and draw or take pictures of your step by step plan!



Respiratory system

Aim:- Learn the structure of your lungs

Find out what your respiratory system does?

Use the web link on learning resources to get some information:-
Under-being healthy - respiration

Respiratory System image
Copyright © British Broadcasting Corporation, 2000
http://www.bbc.co.uk/schools/ks3bitesize/science/biology/respiration1_2.shtml

Physical Breathing

Aim:- Can you describe how you physically breathe

- Using the animation saved on your USB stick called lungfinal(1) (flash file) to do the following activities:-
- Draw 2 diagrams of how you physically breathe (1 breathing in, 2nd breathing out)
- Now write a short explanation of how you breathing in and breathing out

Sometimes they were required to create their own Flash animation to illustrate some action of the body, such as describing how we breathe. Some student 'Flash experts' helped those less familiar with Flash animation. The teacher had uploaded to the Science Faculty web pages some additional resources, which students could access in school – or sometimes at home as part of a homework exercise. At the end of a session, the students either saved their work on USB memory sticks or on the server for the teacher to assess later. All of these activities were considerably aided by the wireless networking.

In another science lesson, adopting a similar approach, students created presentations on the life of the lion. Using the microphone on the Tablet PCs they recorded short audio clips to enhance their presentations, including the audio links on the slides. Students also developed wordsearch puzzles easily, using the Tablet PC pens and saving their handwriting as digital ink.

ANCIENT CATS

The earliest known Cat - *Proailurus* lived about 30 million years ago, the size of a small bobcat.

Such as the saber-tooth and *Homotherium* used to roam from the top of Africa down to Mexico.

To keywords to do with this Project.

My wordsearch about lions

N	O	I	T	A	L	U	P	O	P
E	E	L	I	O	N	S	D	P	Q
E	D	W	V	C	O	E	H	R	O
T	A	C	I	R	F	A	I	L	L
F	F	H	C	Y	N	Q	S	O	O
I	X	A	K	N	Z	B	L	C	E
F	J	J	A	M	P	B	H	S	N
I	F	V	K	A	A	H	U	N	T
H	A	N	G	N	L	G	R	O	T
S	M	N	H	E	R	D	I	N	G

- Lions
- Africa
- Savannah
- Fifteen
- Prides
- Hunt
- Herding
- Mane
- Golden
- population

Think you've found them or you can't find them? Click here!

My wordsearch about lions

N	O	I	T	A	L	U	P	O	P
E	E	L	I	O	N	S	D	P	Q
E	D	W	V	C	O	E	H	R	O
T	A	C	I	R	F	A	I	L	L
F	F	H	C	Y	N	Q	S	O	O
I	X	A	K	N	Z	B	L	C	E
F	J	J	A	M	P	B	H	S	N
I	F	V	K	A	A	H	U	N	T
H	A	N	G	N	L	G	R	O	T
S	M	N	H	E	R	D	I	N	G

- Lions
- Africa
- Savannah
- Fifteen
- Prides
- Hunt
- Herding
- Mane
- Golden
- population

To be obvious for them only!

The students used the Tablet PCs to summarise the topic and take notes about key points during the lesson. Work could later be displayed on the school website, which was accessible by parents and other students and teachers.

Case study 10

Student ownership of Tablet PCs in Year 7

A Year 7 pupil, whom we will call Ali, was an enthusiastic Tablet PC user. He took his Tablet PC with him wherever he went, including his home. He liked its light weight and portability and its 'extra features': "The nice thing about Tablets is you don't have to bring to school extra things like pens and paper. On the Tablet it's easier to write on the screen and to drag shapes – more difficult if I'm using a mouse."

Ali was an 'expert user' and during lessons regularly helped other students find files or overcome some technical difficulty. This was much appreciated by fellow students and by teachers.

He described some of the ICT-related class activities he had undertaken in the previous few days. In science he had investigated how microscopes were constructed, searching websites and taking notes, and had looked at digital cell images to investigate differences in the blood cells in humans and other animals. In maths Ali used the Tablet PC pen to write his answers to a numeracy test on an electronic worksheet prepared by the teacher. In English, the topic being investigated and discussed was using animal testing to cure diseases in humans, work derived from the National Geographic 'Kids' website. Handwriting recognition proved useful when diagrams were included on PowerPoint slides. Titles and labelling would be handwritten on a slide and then easily converted to text. Alternatively, he often saved his handwriting as digital ink.

A history topic on the Gunpowder Plot resulted in creation of a short presentation for a year assembly, developed on the Tablet PC, describing events of that period.

Ali enjoyed lessons in which ICT had a role: "Using Tablets makes learning memorable."

Key lessons learned

- The college's sophisticated ICT infrastructure provided a sound basis on which to integrate Tablet PCs into everyday practice.
- Identifying student 'expert users' was an effective way of encouraging collaborative use and resolving technical issues.
- Ensuring that there was enough 'just-in-time' technical support was important – especially in the early stages of implementation, when reliability proved a problem.
- As with any new technology, staff could easily become discouraged when technical issues dominated.

The Coleshill School

Overview of school

This is a secondary school in a small country town close to a large conurbation. At the time of the case study it had 1,027 pupils and had recently been designated a Maths and Computing College. Some 70% of the pupils came from within the catchment area, with 30% from the nearby conurbation. The school buildings were mainly constructed in the late 1950s.

Description of ICT resources

Coleshill had around 165 PCs arranged in four main suites and satellite areas. It had three servers, wireless and broadband access, two full-time technicians and some laptops.

Tablet PCs and associated peripherals

Coleshill was part of Warwickshire's 'We-learn' project [<http://www.we-learn.com/pfi/>]. Teacher Toolkits provided by the project were installed in 34 classrooms. Each Teacher Toolkit consisted of a slate-style Tablet PC running Tablet 2005, with USB keyboard; data projector and wall-mounted PC; wireless access; the use of remote control software (NetOp), a server and broadband access. It also included a virtual teaching environment (Kaleidos) together with other software and a managed service that provided limited on-site support. The Teacher Toolkits were used in particular areas of the curriculum at Key Stage 3.

On successive 'turns', £18 in coins was moved into Bill's pile while £12 was moved to Jane's. This was then represented numerically. This demonstration was followed with a board exercise and pupils then completed exercises in their books. They were settled and worked well.

The lesson was not entirely typical: such a concrete representation would not usually be used with the top set. The strength of this use was that it enabled physical movement or re-arrangement of number and components – thus supporting moving from concrete to more abstract mathematical representation. It was an example of extending rather than supporting or transforming the curriculum (although uses by this teacher in other classes were transformational). This lesson could have been done on a laptop. However, the facility for drawing and handwriting was used a lot, and examples were shown in response to particular student queries, which could not have been replicated on a laptop. It could also have been done using an interactive whiteboard, but this would have necessitated the teacher always remaining at the front of the class, whereas with the Tablet PC and wireless connection he could move around the class during the lesson, which he felt helped with classroom control. Finally, real coins could have been used, but the very classes that this would help the most would get distracted and it would provide opportunities for many off-task activities. The teacher had worked previously with interactive whiteboards and this experience of what was possible influenced his approach to using the Tablet PC as part of the Teacher Toolkit.

"The obvious problem is the time to switch on the Tablet and log on twice in order to take control of the wall machine....If you are in the same classroom the entire day and can leave the Tablet in there turned on then this wouldn't be a problem. BUT...in the real world, we have to move around from classroom to classroom..."

Humanities teacher

Using a Teacher Toolkit with the top maths set in Year 10

The Teacher Toolkit was used for projecting onto the whiteboard in a lesson about ratios. The lesson showed how different allocations of physical objects (that is, how they are divided) are represented by ratios in maths. It enabled a quasi-concrete representation of money (shown as pound coins) and demonstrated how this could be divided up in a ratio of 3:2. The problem set was that Bill and Jane win £30 in the lottery and share the winnings in the ratio 3:2. This was illustrated by a screen showing three 'boxes': one with £30 in coins in it, and one box each for Bill and Jane – initially empty.

Students' use of a Tablet PC

As described above, much of the Tablet PC use was for whole-class teaching by the teacher. During such whole class teaching the Tablet PC could be passed around between students so that they could present their responses or ideas.

A Year 8 (mixed ability) geography class played 'The Millionaire Game'. This lesson was a plenary of the volcano topic from the 'Natural hazards' scheme of work. The teacher used a PowerPoint template for a version of the TV 'Who wants to be a Millionaire?' game found on the internet (adapted by Mark Damon) and developed questions from the students' current work on volcanoes. He chose the first student

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and then the Tablet PC was passed around from student to student to see who would be the millionaire. The game included questions such as: A number of volcanoes can be found along the Pacific Ring of Fire: a) Fire; b) Flames; c) The Friendship or d) Friends.

The 'ask the audience' and 'phone a friend' features from the TV game were used. Students were focused and found this activity highly enjoyable – and it also involved a sound use of subject knowledge. This example of use would not have worked as well with laptops, which would have been much more cumbersome to pass around between the students.

Both the teachers who were the focus of this case study used this form of interactive whole-class teaching in which the Tablet PC was passed among the pupils. They both found that the students were excited and motivated by working in this way, and it engaged students who in other lessons were often easily distracted. For example, the maths teacher developed lessons in Easiteach about number patterns and formulae where the students used the Tablet PC to create and demonstrate number patterns: their task was to drag squares and place them in particular arrangements to produce a sequence of numbers.

Individual students also sometimes used the Tablet PC. For example, in another lesson a student with 'severe special educational needs' was finding it very difficult to draw the diagrams needed for a project. The teacher set up an Easiteach resource so that the student could use the Tablet PC to drag and drop elements to produce the required diagrams, which she found much less frustrating.

Key lessons learned

- Introducing Teacher Toolkits had made a positive impact in the curriculum areas involved in the project.
- Using the Teacher Toolkits enabled access to a much wider range of resources and a move away from textbooks.
- Using the Teacher Toolkits increased the pace of lessons.
- The Tablet PC use supported and extended the curriculum and both the teachers involved in this case study saw how the technology had already transformed aspects of their teaching or could do so in the future.
- Loading-up and synchronisation time can be problematic at the start of the lessons.
- Using the Teacher Toolkits required extra time for preparation of resources and lessons by teachers as well as extra time for the ICT co-ordinator.
- Teacher ownership of the Tablet PCs would have been more efficient than allocating them to specific classrooms, as it would have facilitated teacher familiarisation and lesson preparation.

The school was at an early stage of use; nevertheless in the areas covered by the project, Tablet PCs were heavily used for whole classroom teaching.

Wilmslow High School

Overview of school

The school is located in a country town. At the time of the case study its catchment area included a wide surrounding area which was predominantly medium to high income. The school had recently been awarded Sports College status, which resulted in many students entering the sixth form directly.

Description of ICT resources

Overall resources

The school staff had use of 78 PCs and 77 laptops and there were a further 380 PCs and 60 laptops for student use. Virtually all computers were connected to a fast Ethernet network and to a 10Mbps broadband link. A 54Mbps wireless network was available in many parts of the school for use with the laptops and Tablet PCs.

Tablet PCs and associated peripherals

The main motivation behind the school's decision to purchase laptops was an Ofsted requirement to increase ICT usage. They wanted PE staff to be able to use IT continuously, both in the classroom and in sports activity areas. The PE department decided that laptops were not suitable either for outside use or in the gym and other areas where there were no desks. The PE department therefore decided to buy their staff Tablet PCs that they could use standing up. Several staff had poor IT skills and it was felt that a Tablet PC would enable them to write instead of using a keyboard. They would also be able to interact with the network wherever they were.

The PE department purchased 12 convertible Tablet PCs, running the original Tablet operating system, for use by its staff to support administration, preparation and teaching of PE. These were allocated to individuals in September 2004. PE staff were located in several offices sited near the various sports teaching areas, which had previously made direct communication difficult.

The Tablet PCs had access to the school network and the internet from within the school campus, using a wireless connection in outdoor PE areas and classrooms, and a wired connection in offices.

At the same time as introducing the Tablet PCs, the PE department created a rich electronic teachers' resource pack to support the four strands of the recently restructured sports curriculum: Health-related knowledge and understanding, Improvement and assessment, Tactics and composition application, and Skill development (HITS). This electronic resource pack for HITS was stored on both the server and the Tablet PCs.

Using the Tablet PCs for sports analysis

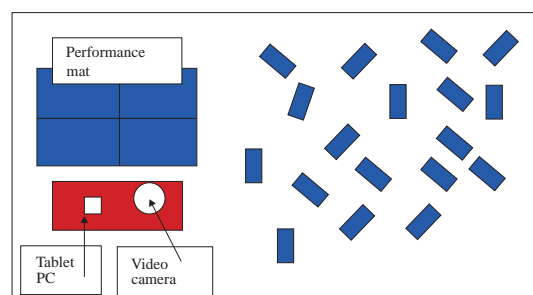
To support the evaluation and analysis of performance during teaching sessions, a digital video camera was set up in the sports hall and gym. The digital images from the camera were fed into a Tablet PC and a specialist program called Swinger Pro was used to display the results on the Tablet PC's screen. By using a 'delay feed' option, the student could execute a complete performance or routine and then view the feedback, either individually or with the teacher. The camera could be set to record the performance at the same time, enabling it to be reviewed later in another lesson or location.

Coaching the high, deep serve in Badminton

A group of eight Year 10 girls were practising this new skill in the Sports Hall. Their coach recapped the technique and stressed the need firstly to position the body and feet correctly and secondly to follow the stroke through. After some initial practice, the girls were split between two courts, each serving six shuttles across the net to the receiving court. The Tablet PC and camera were set up to video the server on one court. Each girl was encouraged to study her performance, identify strengths and weaknesses and record them on a prepared paper template.

Focusing on straight legs during a gymnastics routine

A class of 18 girls from Year 7, a 'less able' group, were practising their individual prepared gymnastics routines on mats in the gym. A group of mats was positioned at one end with the Tablet PC and video camera set up to focus on this area.



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The girls were asked to identify various requirements of the routine such as balance, straight legs or flow between positions. Following individual practice, girls who had not yet viewed their performance with the video and Tablet PC were allocated turns. They each performed their routine on the block of mats and watched themselves afterwards on the Tablet PC.

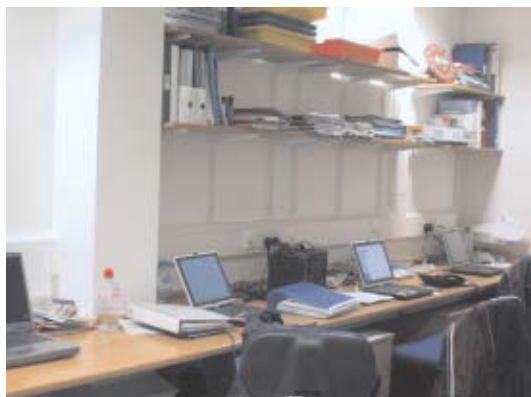
This was a new experience for them and they were a little self-conscious. However, with the teacher's help, they were able to identify the positive aspects of their performance and the aspects that needed practice.

The camera had also recorded the session and during the next lesson the video was shown to the group. The class analysed individual performances. Students were encouraged to focus solely on straight legs and to identify movements in the routine which satisfied this criterion. Then they focused on aspects where legs were not straight and, where they were not, were encouraged to analyse why.

Use of the Tablet PCs by sports staff for administration, preparation and classroom teaching

The new HITS resource pack contained details of student/staff timetables which identified for every session the unit and lesson number. It also contained lesson plans and a store of resources.

As soon as staff arrived in the morning they switched on their Tablet PCs to access emails and check their teaching commitments for the day. Unless they were needed for teaching or registration, the Tablet PCs remained in position ready for use in spare time and lesson breaks.



Covering staff absence

At the start of the day a member of teaching staff phoned in sick. The timetables were checked on the Tablet PC and cover staff identified. Supply staff were provided with printed copies of the registers and lesson plans. Other PE staff were emailed details of their requirement to cover.

An anatomy and physiology revision lesson

One member of staff used his Tablet PC to check the HITS resource pack for information on the lesson and then search the internet for some visual material to use with his Tablet PC and a data projector in the classroom.

The focus of the lesson was the cardiovascular system. The teacher had identified a link to an online crossword covering this aspect. Using the Tablet PC, network connection and the data projector, he displayed the crossword on the whiteboard. The students' task was to answer as many of the clues as possible in a given time, recording their answers on paper. Students volunteered answers, and any incorrect answers or misconceptions were identified and explained by students or the teacher.

Key lessons learned

- With a diverse range of initial ICT skills and confidence it was important to move slowly.
- To build ICT skills they needed to engage staff in the use of ICT.
- Administration and preparation was a good place to start, as staff could soon see benefits.
- A good electronic resource, such as the HITS teacher resource pack, proved to be of recognisable value.
- The use of Tablet PCs was expanded by providing teachers with concrete examples of how they could be used and by creating a bank of useful electronic resources such as video clips, images and internet links.

The result of using Tablet PCs alongside these approaches was that staff had begun to expand their use of ICT into preparation and teaching in both classrooms and sports areas. Previously much of the usage focused on the Tablet PCs' wireless connectivity and portability. With the advent of better weather and the staff's improved confidence in their use, they expected to expand usage to take fuller advantage of the slate orientation and features.

In the four months they had been using the Tablet PCs, the major achievement had been to engage and excite the staff in using the machines not only for administration and planning, but also in some of their teaching. They were looking forward to expanding the use of the Tablet PC's features, particularly those that distinguish it from a laptop.

Benchmarking of the case study schools

The case study schools were benchmarked in order to see if their performance was comparable to other similar schools in the 2004 academic year. Where comparable data was available, no significant differences in performance were found between the case study schools and their 'matched' schools.

Procedure

We drew up a list of comparator schools matched according to the following measures listed in order of importance.

1. Phase of education (primary or secondary)
2. Location (urban or rural)
3. Acorn group type (demographic information on the schools based on postcodes)
4. Sex (single sex or mixed sex)
5. Statutory lowest and highest ages of entry (including sixth form, where possible)
6. School size (total number of pupils)
7. Proximity (schools within the same LEA, where possible)

A comparator ratio of at least one target school to two comparator schools was employed and the independent variable used to conduct the benchmarking was school type (target or comparator). The dependent variable was drawn from a range of nationally available performance data from the 2004 academic year.

Infant school and special school

These two schools could not be benchmarked owing to lack of available comparative institutions and/or data.

Key Stage 2

Each of the six target primary schools was benchmarked using Key Stage 2 average point scores, defined by the DfES as the points allocated to each pupil's results in each test, divided by the total number of eligible pupils in each subject. A between-subjects analysis of variance (Anova) was conducted with the type of school (target or comparator institution) as the independent variable, and performance score as the dependent variable. No significant difference was found between these two groups for performance in 2004.

Secondary schools

Secondary schools were benchmarked using the average point scores per 15-year-old for GCSEs and GNVQs (calculated by dividing the total number of points achieved by students aged 15 by the number of 15-year-olds on roll) and, where appropriate, using average point scores per examination entry for GCE and VCEs (calculated as the sum of the points awarded to each 16–18-year-old student, divided by the total number of GCE/VCE examination entries). Again, between-subjects Anovas were conducted with school type as the independent variable and performance outcome as the dependent variable for both GCSE and GCE examinations. No significant difference was found between these two groups for performance in 2004.

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