

The Impact of Technology: Value-added classroom practice

Final report

**Charles Crook, Colin Harrison, Lee Farrington-Flint,
Carmen Tomás, Jean Underwood**

September 2010

Contents

| | |
|---|-----------|
| Acknowledgements..... | 3 |
| Executive summary..... | 4 |
| 1 Introduction | 6 |
| 3 Emerging themes: contextual factors and impact on learning | 25 |
| 4 Discussion and conclusion..... | 58 |
| Bibliography | 61 |
| Appendix 1: Technical note method..... | 63 |
| Appendix II: Learning practices | 71 |
| Appendix III: Cases on learning with ICT in six schools | 78 |

Acknowledgements

This research project was carried out by the following:

The University of Nottingham: Charles Crook, Colin Harrison, Carmen Tomás and Brett Bligh

Nottingham Trent University: Jean Underwood, Phil Banyard, Lee Farrington-Flint, James Stiller and Lucy Betts

We owe a deep debt of thanks to all the schools, managers, teachers and students with whom we have been working. We applaud their cooperation, cheerful assistance and highly professional skills.

Executive summary

This report extends Becta's enquiries into the ways in which digital technologies are supporting learning. It looks in detail at the learning practices mediated by ICT in nine secondary schools in which ICT for learning is well embedded.

The project proposes a broader perspective on the notion of 'impact' that is rather different from a number of previous studies investigating impact. Previous studies have been limited in that they have either focused on a single innovation or have reported on institutional level factors. However, in both cases this pays insufficient attention to the contexts of learning. In this project, the focus has been on the learning practices of the classroom and the contexts of ICT-supported learning.

The study reports an analysis of 85 lesson logs, in which teachers recorded their use of space, digital technology and student outcomes in relation to student engagement and learning. The teachers who filled in the logs, as well as their schools' senior managers, were interviewed as part of a 'deep audit' of ICT provision conducted over two days. One-hour follow-up interviews with the teachers were carried out after the teachers' log activity. The aim of this was to obtain a broader contextualisation of their teaching.

The learning practices that we identified as mediating ICT for learning are presented as a taxonomy. This taxonomy is used to classify the lesson activity reported in the logs. We argue that ICT has reconfigured classroom practice in the project schools in important ways. Among these, we would highlight the following consequences:

- **ICT makes possible new forms of classroom practice.** This is apparent in three particular respects: (1) the reconfiguration of space such that new patterns of mobility, flexible working and activity management can occur, (2) new ways in which class activities can be triggered, orchestrated and monitored, (3) new experiences associated with the virtualisation of established and routine practices – such as using multiple documents in parallel or manipulating spatial representations.
- **ICT creates the possibility of a wide variety of learning practices.** Overarching this variety are three central activities which are significantly enriched by the increasingly ubiquitous availability of technologies: (1) exposition which is animated by the opportunity to invoke rich shared images, video and plans, (2) independent research which is extended by the availability of internet search opportunities, and (3) construction which is made possible by ready-to-hand ICT-based tools.

In Chapter 3 we identify emerging themes that surfaced from the interview data and relate these to the findings of the teacher log exercise. We identified as emerging themes:

- evolving vision and leadership
- developing an infrastructure to enhance out-of-school learning
- multifaceted staff development and the role of students
- redefining learning spaces
- impacts of ICT on four particular aspects of learning: differentiation, inspiration, coherence and engagement
- exploiting the affordances of new media in teaching and learning.

The emerging themes focus particularly on a system-level analysis of the conditions under which ICT has an impact on learning. However, they echo many of the issues that surfaced as important in the lesson log analysis: the use of space—particularly new ways of using space (including virtual spaces) to improve learning—and the use of ICT to inform a wide variety of learning practices, a number of which involved the students in new forms of activity.

None of the schools involved in this research project saw their journey towards e-maturity as complete. In every school there were areas of relative success and failure. Every headteacher saw embedding ICT in learning as work in progress, particularly in relation to home-school links and the involvement of parents.

1 Introduction

The purpose of this project is to support Becta's continuing work to identify the ways in which technology can be used to raise standards of attainment in schools. The project provides insights into the ways in which the use of digital technologies mediates and supports practices of learning.

In defining the remit for this research, Becta posed these five questions:

1. What are the ways in which innovative and effective schools are using digital technologies to support learning?
2. Which technologies are being used and how?
3. Is there evidence (qualitative and/or quantitative) that these are supporting learning? If so, what?
4. What is the rationale for use in each context? How does this fit in with current understanding about ICT and teaching and learning?
5. Are there any identifiable similarities across contexts from which it is possible to generate interpretive hypotheses about how and why digital technologies are beneficial?

Question 3, arguably, is at the heart of an unease related to the difficulty of finding causal relationships between resources in schools, in this case ICT, and learning. The demands of finding sustainable answers to this particular challenge should not be underestimated.

The general emphasis in prior studies has not focused on the *processes* by which ICT might have an impact on the practices of learning. There is a significant 'problem space' between the introduction of ICT in an educational setting and the measurement of student attainment. Moreover, that space is probably not well described as a series of causal steps, the general shape of which may somehow describe a successful or less successful trajectory of impact. The space is less a chain and more a set of patterns that reflects complex interactions. It may be more helpful to think of it as an ecology: one in which a complex network of interacting influences is shaping that trajectory in a much more subtle fashion.

Central to our investigation of the complex relations between ICT and achievement is our adoption of a contextualised view of school settings. In the best of circumstances, the practices that are enabled within them will offer fertile grounds to support a rich variety of learning experiences. Impact relationships in this context are

best understood as the deep relationships between an institutional context and the way in which innovative practices emerge and are sustained within them. An ecological approach allows a more fine-grained perspective that links the school setting, the ICT tools available in it, teachers, and their practices. It also aims to generate insights into the complex interplay of the setting; the tools and the individuals by adopting a strategy that is both top-down and bottom-up in its analysis.

Our rationale and approach are detailed in the next section on impact and outcomes.

1.1 Impact and outcomes

In this section, the tradition of research associated with ICT impact will be sketched in order to locate a context for the present project. Accordingly, what is said here is summary in nature and will not invoke details of particular studies or arguments.

The term 'impact' has become associated in the area of educational technology with a form of research inquiry that relates the use of ICT to learning outcomes. An imperative for conducting such research is found in the expectation that recruiting digital technologies into educational practice will bring about useful benefits to students. At the same time, there is awareness that doing so represents a significant investment – not only in terms of resource procurement, but also in terms of winning the hearts, minds, and confidence of staff. Yet the rewards of ICT appropriation are potentially considerable – at least if doing so fulfils the popular expectation that gains will be particularly felt in the area of 'knowledge economy' skills.

Impact research is found in two broad forms. First there are relatively short-term focused studies that consider the fate of particular ICT-supported practices in a relatively piecemeal manner; these can be referred to as 'contained' interventions. They investigate how experience of these contained practices is associated with positive gains in learning outcomes. The second form of research addresses outcomes associated with large-scale adoption of educational technology. This allows consideration of claims regarding the benefits to institutions of investing in ICT as a general part of their strategy to support learning; these can be referred to as 'system-wide' interventions.

Both types of research are controversial, resulting from the methodological and interpretative challenges that have arisen. The general nature of these concerns centres on these issues:

- It can be hard to interpret the significance of results that arise from the standard format adopted in both forms of study
- The size of effects in contained studies is relatively modest

- While contained studies still tend to encourage scaling up of ICT to a system-wide level, the size of learning outcome effects associated with such investment is again modest.

Our own view is that these problems are inter-related, and they risk cultivating an unjustified scepticism about the value of investing in ICT as a support for students. It is therefore important to confront patterns of results in current impact studies and to evolve methods that probe the phenomena more deeply. At the core of uncertainties arising from existing research is the systemic nature of the practices that are being scrutinised in these studies. In short, sites of teaching and learning are complex ecologies that will have attained distinctive states of equilibrium. Such states may seem more or less healthy to an outside observer but they are, nevertheless, in careful balance. A new technology introduced into such systems can be absorbed in complex ways. Balances can be disturbed to an uncertain extent and with uncertain modes of adoption. Moreover, the fate of learning experiences that take place could vary a great deal.

The current state of the field seems to require a more generous conception of 'impact' as the central concern of research. What needs to be better understood is the impact of ICT on learning *practice* – as well as learning outcome. However, the existing literature does not give a clear picture of the terms in which practice might be scrutinised or the terms in which such impacts might be expressed and recorded. What is needed, therefore, is research that documents the reported experience of integrating technology into ongoing practices of teaching and learning, as they are pursued at the classroom level. In particular, it will be important to acknowledge emergent impacts of ICT in situations where it is becoming pervasive within educational practice – rather than seeing it as a resource that is appropriated in a piecemeal manner in a corner of the curriculum. Piecemeal approaches disturb the larger ecology of teaching, not just the local ecology of individual lessons.

2 Findings from teacher logs: an analysis of ICT impacts

The sections below report on the information gathered in the 85 teacher logs, based on lessons using ICT. Section 2.1 presents a quantitative summary of teachers' ratings on overall lesson success. Section 2.2 shows the findings on space and the impact of ICT in the classroom. Section 2.3 presents an analysis of the learning practices in lessons where ICT is used. Section 2.4 presents information on the engagement of students during the lessons with an analysis of teachers' ratings and comments. Section 2.5 provides a summary of the impacts on learning as derived from the teacher log data. Section 2.6 provides a conclusion to the section.

2.1 Contribution of ICT to overall lesson success

In their logs, teachers provided ratings on the achievement of lesson aims and the rate of progress in lessons where ICT had been used. The ratings are shown on a sliding scale (ranging from negative to positive) and are based on teachers' perceived success of general aspects of the lesson.

The ratings of individual lessons indicate that teachers perceived these 85 lessons to be highly successful. Figure 1 presents teachers' ratings on the success with which the lesson aims were achieved. Figure 2 shows the teachers' ratings on the rate of progress in the lessons. Both figures show ratings from 1(negative) to 8 (positive) and the number of lessons out of the total of 85.

Figure 1 Teachers' rating of success in achieving lesson aims

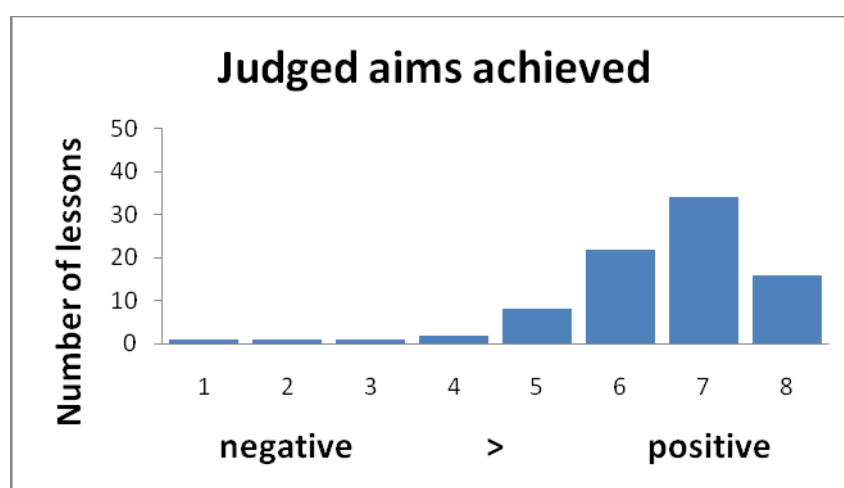
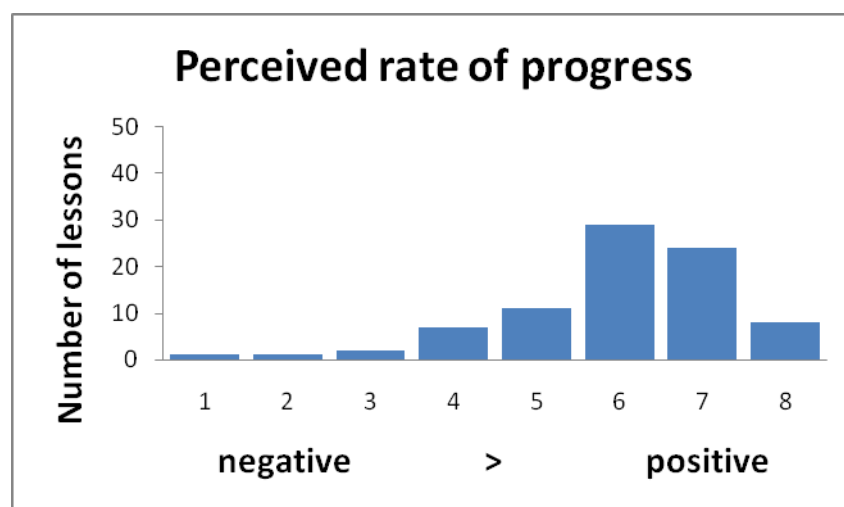


Figure 2 Teachers' rating of progress in lessons



These ratings express the teachers' perceptions of the participants' experience of these lessons. The present data do not represent an outside observer's independent evaluation of lessons. It is not possible to report and contrast self-evaluations from lessons that did not involve ICT. However, our conversations with participants reassured us that the lessons in this corpus are representative and that, in general, they reflect a positive experience of the contribution of ICT to overall lesson achievements (as shown in the two graphs above).

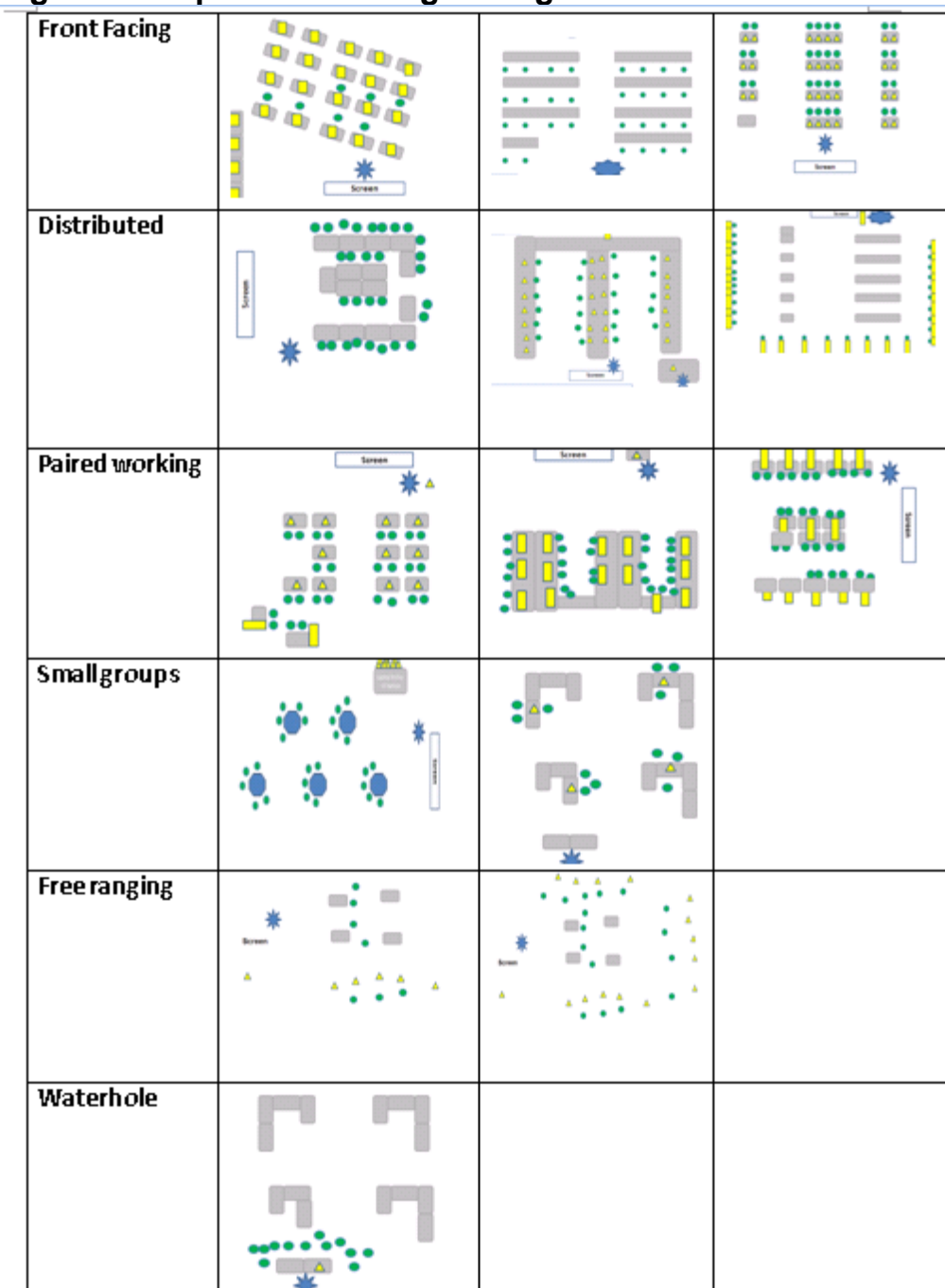
2.2 Space: ICT and its generalised impact on the classroom

The analysis that follows focuses on classroom space. In our sample, this might be a personal space that is regularly used or it might be a shared space, particularly one that is well-resourced with technology. Our interest is in how far, and in what ways, the adoption of ICT serves to reconfigure activities in the classroom more radically.

We discuss this in relation to themes of physical layouts, affordances for movement, monitoring, classroom management, orchestrating activity and the experience of interacting with screens (as opposed to physical materials).

In reviewing the spatial configurations that teachers described for the 85 lessons, we detected six basic patterns that relate to the mobility of the technology in each case. Figure 3 shows these arrangements.

Figure 3 Six patterns for organising interactions with ICT



Green circles depict students. Grey blocks are working surfaces. The teacher (depicted by a star) and screen (labelled) are also shown in most instances.

Front facing is a common and familiar arrangement and one that is sometimes dictated by the fixed nature of the technology. Other configurations show possibilities for collaborative work or for using a single computer as a site for whole group

discussion (the waterhole). In most project schools each student potentially had access to their own computer and, often, this was a laptop. This allowed the configuration of spaces to be variable and flexible. The free-ranging organisation was an extreme version of the flexibility that small computing devices now allow. It also is a reminder that 'technology' does not simply mean PCs or netbooks. Some class activities depend on access to a variety of technology tools perhaps only briefly:

..to me, ICT's not just working at the computer and typing a document, it's more having them walking around a room filming each other, taking pictures, and so on. (School 7 Teacher 4)

This flexibility is a strong requirement for some forms of activity. For example, one teacher described a music lesson that involved composition, review, and performance filming. This range of activity required a number of function-specific sites, including some that offered silence or privacy:

Certainly when they are composing they need to be able to hear what they are doing and just have that separation and in this case filming as well... the advantages of the netbooks of course was that they could take them with them. (School 5 Teacher 2)

The flexibility of the layouts and mode of work enabled by a particular technology might sometimes carry a useful acknowledgement of more mature social relationships (or protection from more patronising ones):

I say 'do log on and then we'll sit in the middle and discuss what we're going to do and you can write notes and then go back'. That's quite a nice flexibility in that room... because [in] the old computer room, we used to have [to say] 'now turn your chairs around and face...' and it just doesn't really work with Year 11. They think you're talking down to them. (School 7 Teacher 5)

A theme in the discussions of these configurations was the possibility of more fluid patterns of movement in a space. This was an opportunity that might be alien to some students:

..and two of the pupils couldn't cope with the fact that they had to move around the room but they need to learn that. They got told 'if you can't cope, you do the textbook alternative' and they soon realised that it's really worth just being able to walk around the room. (School 3 Teacher 3)

However, the opportunity for active in-class movement may be something that teachers need to develop confidence with also:

When I came into teaching it was having the computers in front of you and I would demo this task and then you would get on with it. Whereas [now] I think it's become [about having] a lot more movement around the room... being a more confident teacher and being stronger in the classroom, it gives me the opportunity to go off and do these things...definitely involving the students in being up and active in the classroom and them taking part in leading the class as well. It's not just me being up there all the time. (School 2 Teacher 3)

This flexibility of teacher movement was often associated with the opportunity for more effective monitoring of student activity and more effective openings for feedback:

I wanted to get away from the traditional two desks and the look of the classroom with lots of two parallel double desks facing the front [to create a] slightly more relaxed atmosphere. I need to be able to get round to all the students because there's a lot of situations where I will need to literally look over their shoulders. (School 7 Teacher 5)

However, some classrooms incorporated other forms of technical design that made 'looking over shoulders' redundant. This applies to having central monitor screens that display what is going on across the class:

On the net monitor you have access to all their screens from the front. If I am feeling really mean, then all their screens will be up there. So even if I am working with someone else, then they are actually keeping an eye on each other, as they can see when someone has flicked onto something... When you want to take over their screens, you can literally lock them down and you can add your input... If there is something that you spot they are all doing, then it's great. (School 2 Teacher 6)

These examples illustrate generic influences on classroom dynamics that arise from adopting ICT as a tool – independent of the particular curricular contexts for its use. These shifting patterns illustrate a greater flow of classroom activity and, in more sedentary lessons, a more flexible potential for monitoring and feedback. On the whole, these impacts would be welcome. However, the appropriation of ICT comes with generic consequences that can be less welcome, as in the next example that concerns the demands of management.

Some teachers noted the properties of traditional media (say a textbook) versus the hidden overheads of ICT:

For them to get the same out of it as a traditional lesson I have to work far harder... because I think there is not a lot that [could] go wrong with a book, to be honest. Whereas with a laptop, because of slow pages or because it's on a huge network or

some haven't charged it up properly...sometimes it says you have to log in again...or it goes to hibernate... Because of that you are dealing with 4 or 5 problems at once, which rarely happen if you are using [more traditional methods]. (School 5 Teacher 1)

This is a clear stress that is common when ICT fails to deliver. Teachers can readily improvise a recovery from failure when they use traditional media, whereas an ICT-mediated session demands greater depth of planning:

In some lessons, if you are heavily reliant on the technology and it isn't there, then you really need plan C because plan B is [about] doing something else with [the technology]. (School 5 Teacher 1)

Finally, familiar classroom interactions can be disturbed when an established learning practice seems to not transfer seamlessly from real world materials to (what we might term) virtual materials. One teacher makes this point about the virtualisation of practice. This is in relation to the contrast between corporate attention to events on a single front-of-room screen versus corporate attention to the same to-be-shared events as delivered to individual screens. The latter perhaps recruits attention with a different intensity:

I'm not really sure why. I've tried thinking if it's because there's no one else in their line of sight, they're just looking straight to screen whereas if they're looking at the board, there might be four or five people in front of them and they might want to poke them and mess around. It's incredibly focused when you do it like that, even if it's just me speaking, they won't look up at me, they'll just - eyes on the screen and focus on what's being done. (School 3 Teacher 1)

Other features of the media that make familiar actions feel different were also identified. This maths teacher queried the impact of making geometric forms in real versus virtual media, suggesting that traditional methods can be more effective in some instances:

When you do construction on any geometric software, it doesn't look like a compass. It doesn't look like a protractor. It nicely snaps to the lines, it hasn't the same feel as someone else doing it... I've found now, just doing equations and stuff, they're a lot more focused seeing [me] write it out. Even it slows me down a bit. (School 3 Teacher 1)

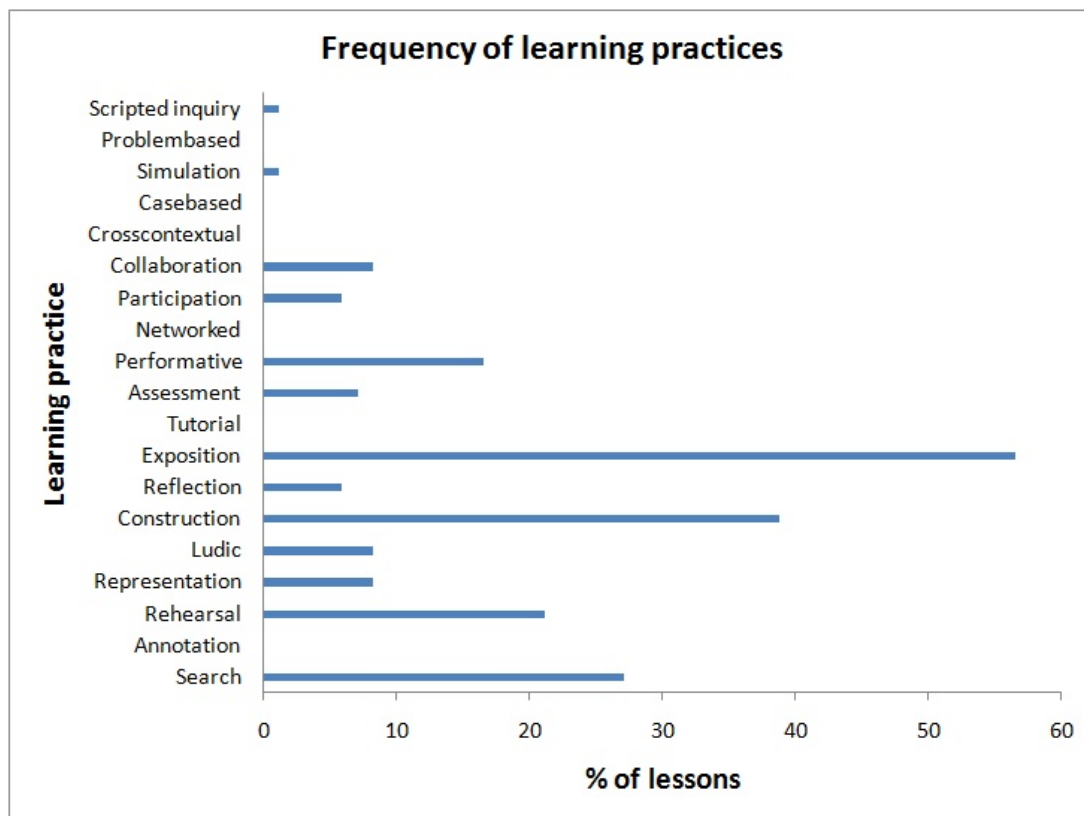
Another teacher invoked the physicality of the desk – as a space where multiple documents might be more comfortably managed.

Students can get confused by this multitasking: [having] many different documents all open at the same time on the screen. I think they cope much more naturally with multiple sources when they are laid out in front of them as physical things. Another point like this is the transient nature of what's on the screen. As a teacher, you can't always see where they have got to. It's lost from view and there is this feeling I have of not wanting to touch their laptop. (School 6 Teacher 4)

This section has considered the overarching impacts of ICT at the level of classroom structure and organisation. The impacts of ICT become apparent when the technology is appropriated widely and used regularly. In particular, these impacts apply to the practice, increasingly common in all these schools, of students each having access to a personal (networked) device. ICT used in this way invites new patterns of movement and study flexibility. It also creates opportunities and demands for student monitoring and for classroom management. Finally, there is some awareness of how familiar practices may be disturbed when they undergo translation into more virtual formats. On the whole, participants were positive about the nature of these impacts but acknowledged that a comfortable classroom experience depended on good technical support and robust infrastructure.

2.3 ICT and learning practices

The analysis of learning practices has been derived from the teacher records on activities where ICT had a mediating role. Appendix I shows definitions of these learning practices. The data refers only to interactions mediated by ICT. So, for instance, there might have been collaborative work in lessons but it would not have been recorded as such if the interactions were not mediated by technology. It was, of course, possible for a lesson to involve more than one kind of learning practice. In fact, it was common to find this kind of variety. Figure 4 shows the percentages of learning practices represented across the 85 lessons. The percentages in the graph indicate three dominating practices: exposition, construction and research. It is also notable from the percentages that certain forms of widely-noted ICT-based activity are not frequently represented: lucid activity and rehearsal of skills, for instance.

Figure 4 Distribution of learning practices involving ICT

The low percentages of some learning practices mediated by technology (that is, annotation, tutorial, networked, problem-based, cross contextual and case-based) may indicate that some practices such as annotation might be more suitable for a period of private study. Other learning practices do not fit the communal nature of classroom life – learning in tutorial exchanges, for instance.

The second point to acknowledge is that the classification of occurrences for these practices only draws upon instances where the teacher identified a significance of the technology for that activity. In particular, the use of ICT for expository purposes (such as PowerPoint) was probably more frequent than was identified in notes and interviews. Therefore, the profile of learning practices incorporating technology given in Figure 4 is based upon those where the ICT mediation was explicitly invoked by the teachers and, by implication, was regarded as playing a significant role.

Exposition was not the exclusive format for any of these lessons, although it played at least some part in most of them. In fact, the overall impression of how technology contributed to these lessons was one of stimulating activity and exchange. The format for expository interaction commonly involved PowerPoint, but it was by no

means the only way of presenting ideas to a class. For instance, many lessons arranged student activity to be triggered by sharing short extracts of video. These lessons were often acknowledged for their success in stimulating class discussion. Construction similarly was not dominated by the making of PowerPoint's but included other forms of portfolio work and video recording. Much of what was recorded as 'search' and 'performance' was integrated with this activity of construction. Searching was not confined to topic research of the kind associated with the ubiquitous Wikipedia. It was more likely to involve finding images, film, examples, and illustrations to support the development of some student-rich media product. Many lessons included space during which these products were 'performed' and made the focus of class discussion and/or assessment.

In summary, the graph shows that the impact of ICT learning interactions was concentrated on expository, construction and search activities. As the descriptions of teachers also revealed, the expository activity supported teachers but the knowledge construction activities were managed by students – often collaboratively. In this sense the mediation of learning by ICT had an impact on the interactions of teachers and students. This analysis is best understood as providing a cross-disciplinary perspective with insights into pervasive practices across the curriculum. The lessons analysed covered a wide area of the curriculum (geography, English, MFL, maths, science, design and technology and music, among others). Some learning practices that may be congenial to specific disciplines may seem underrepresented (simulations in science, or representational tools in maths, for instance) due to the broad nature of the sample. Taking this into consideration, it is fair to conclude that ICT has an impact on learning practices in a rich variety of ways. In highlighting exposition, construction and search, the cross-curricular snapshot conveyed in the present data identifies key pervasive learning practices.

2.4 Engagement of students in lessons

Teachers rated on a scale from 1 (negative) to 8 (positive) the student engagement during lessons that involved ICT. The summary of the number of positive and negative ratings on behaviour is shown in Figure 5 and on engagement in Figure 6. On the whole, these summaries indicate that students' behaviour and engagement was highly positive during the reported lessons.

Figure 5 Teachers' rating of student behaviour

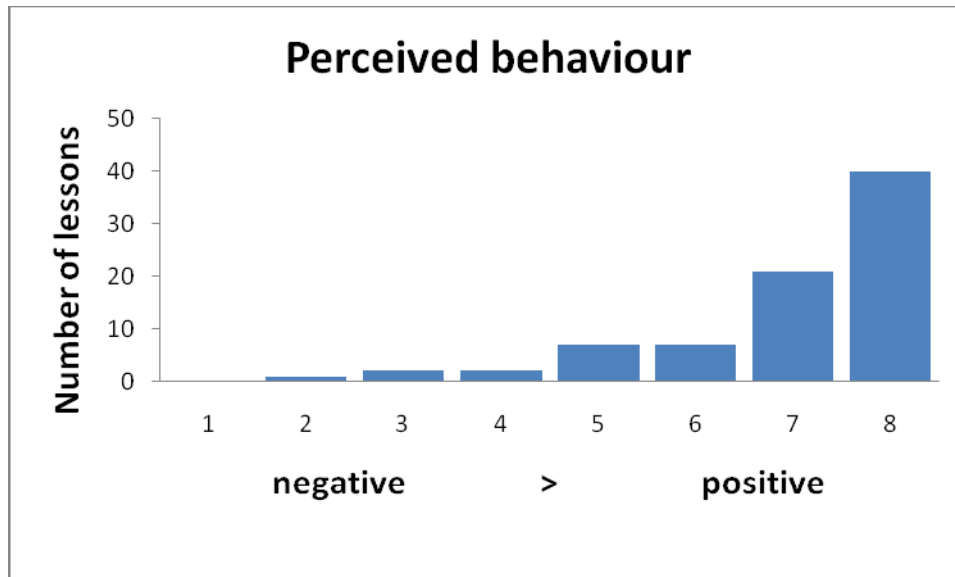
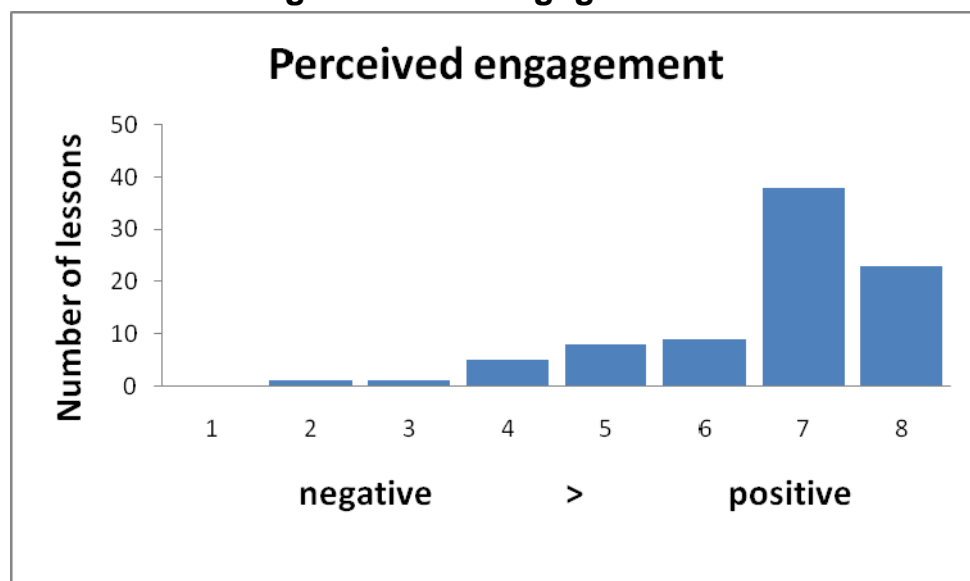


Figure 6 Teachers' rating of student engagement



The ensuing interviews with teachers on their own ratings provides further insights into the subtle connections by which ICT was perceived to have contributed to positive behaviour and engagement ratings. The teacher commentaries provide some insights into this feature of ICT use. In teachers' own words, the factor of engagement with technology was often linked to two other words, 'fun' and 'enthusiasm':

Enthusiasm, I would have put for the first one because I'm a great believer that if they're enthusiastic, then they're going to learn. If they're happy and enthusiastic and open minded, they will learn. (School 7 Teacher 5)

It is useful to look more closely at the vocabulary of explanation used by the teachers to talk about the outcomes of these lessons. Table 1 below is based on an analysis of the log question, "What made the lesson work?" and teachers' written reflections on their 'success of the ICT' rating. A total of 69 lessons offered commentary that permitted this analysis. These comments were content analysed and the categories in this table derived. The numbers in the right column indicate the number of comments that referred to the coding category in the central column. These categories were derived in a grounded manner, viewing the comments in terms of success features that were teacher (or teacher > student) focused or student (or student > student) focused and that were associated with the structure of the ICT task.

Table 1 Concepts invoked in teacher descriptions of lesson success

| | | |
|-------------------------------------|------------------|----|
| Teacher-Student relationship | Differentiation | 12 |
| | Discussion | 7 |
| | Intervention | 6 |
| | Monitoring | 3 |
| Teacher performance | | |
| | Exposition | 5 |
| | Improvisation | 1 |
| Student-Student relationship | | |
| | Group discussion | 7 |
| | Peer teaching | 2 |
| | Competition | 1 |
| Student Experience | | |
| | Participation | 4 |
| | Performance | 3 |
| | Choice | 3 |
| | Exploration | 2 |
| | Autonomy | 2 |
| Task Features | | |
| | Personalised | 12 |
| | Variety | 11 |
| | Structure | 11 |
| | Good stimulus | 9 |
| | Access | 3 |
| | Novelty | 2 |
| | Challenge | 1 |

As will be shown in Chapter 3, the factors of differentiation and personalisation were strongly associated in teachers' perceptions of successful outcomes. The management of 'variety' within lessons was another factor that was frequently invoked in close connection with student engagement. The category of 'structure' is also linked with this, as it refers to the way in which ICT might allow teachers to orchestrate that variety and keep the lesson animated.

Just being able to break tasks down to give the variety... For a weak group, you have got to break it up... The way to do that is to use - whether it's using videos , DVDs, using the computer, whatever it happens to be - to break it up....it's the variety you have to go for. (School 2 Teacher 6)

Of course, ICT is very effective in delivering variety of experience but it needs to be considered that this could lead to the neglect of other sources of engagement. Some teachers recognised the way in which the technology could take over engagement management in this sense:

I have taken this on board because it's been all new singing all dancing using all the computers and everything. We got to the stage where every week I was using the music technology. But this year, I have drawn back, so we were doing an African drumming session and yesterday we were doing electric guitars and kit. I think that if you overuse the technology, the kids get bored with it and they have said to me 'Oh no not computers again'... As a teacher, you think you have got all this stuff and then they say 'it's boring', but I do understand that they don't want to be doing the same thing all the time. (School 2 Teacher 4)

While the dominant vision of ICT was as a source of engagement, and while the factor of potential variety in experience was stressed, there was also an awareness expressed by many participants that this was neither magical nor reliable in the way that it worked. In the rush to acknowledge the natural appeal for young people of using technology, there has been little consideration of its habituation or the need to plan for appetites that might be increasingly demanding of novelty:

I think that's wearing a little thin now...so we've got into doing computer games, as in ...the Question of Sport board and things like that. Again, you can only do that once or twice because, otherwise, that becomes commonplace. So the thing that I was getting into last year, that they responded to so well, was the use of themselves, so videoing themselves... (School 7 Teacher 5)

The Year 11 class who undertook those series of lessons with me is doing extremely well but it's like any other method. If you don't watch it, it's 'Not another bloody diagram' sometimes. You've got to plan your lessons fairly intelligently so they're not doing the same activity or task or 'Here comes another YouTube clip'. (School 7 Teacher 1)

These concerns came through in talking about the dangers of encouraging certain forms of creative projects with ICT too often. It could be thought of as a kind of 'constructionism fatigue' whereby students become weary of using technology to produce the same kind of product (PowerPoint, leaflet, video and so on) to illustrate a curriculum idea:

In six months time it's, 'Right we are going to do another filmed assessment' and then: 'Oh do we really have to do that sir? Can we do something else?' (School 5 Teacher 2)

You do get the child who will say ‘Oh no, not another leaflet’ and it is that sort of need [which encourages us] to look at the wider school and think, ‘OK, how many times are we asking a child to produce a leaflet across all the subjects?’ Because if [teachers in] every subject are doing that, then it’s not effective use of ICT. So it’s actually about who is doing the core teaching – this is what makes a good leaflet and the right programme and, yes, consolidating it. But you don’t want to repeat it more and more, as it gets just as boring as the old stuff. And that’s the same with DVDs. They say ‘Oh no, we watched a video last lesson’ and you have no idea of that. So it’s really [that schools need to have] a more coordinated approach to their curriculum... We will almost switch them off through technology without realising it. (School 2 Teacher 6)

This last observation draws attention to the need for a higher level of lesson co-ordination within a school when ICT is used extensively. It has been stressed here that the technology encourages a shift towards constructivist and performative kinds of project work. However, these exist in a limited range of genres and students may become impatient with exercising these in the interests of what they see as teaching ‘devices’. Teachers may need to be more fully informed of how their colleagues are deploying ICT, so that they can make their own choice of project genre in a way that enables more variety to be achieved.

Having acknowledged that particular challenge, the creative work made possible by certain stock activities can lift an activity from the level of novelty to the level of a more potent experience:

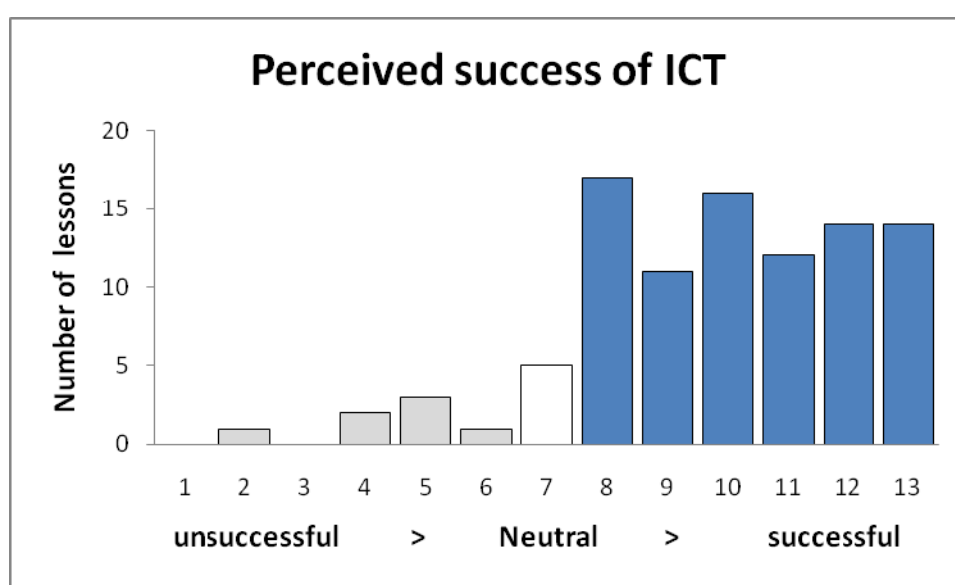
How do I get them to analyse or synthesise using e-learning and then use that as the basis of what I do in my English lessons? It’s gone from, ‘Wow they have cameras, let’s have some fun’ to being a really useful and powerful tool. (School 6 Teacher 1)

In summary, the reports of these lessons are characterised by a strong sense that ICT contributes to the engagement of students. The opportunity to inject variety of experience into lessons is strongly emphasised in teachers’ own appraisals of their lesson success. Again, this discussion warns against treating the technology in a piecemeal way. While technology does mediate distinct forms of learning interaction, that mediation needs to be viewed across all learners’ experiences. One consequence of increased opportunities to vary class activities is that such variety needs to be managed so that it remains fresh and experienced as such. That may call upon finer levels of teaching co-ordination and mutual awareness. One may expect the adoption of shared learning platforms to contribute to meeting this challenge.

2.5 ICT success ratings

In this section, the records and interviews provided by participating teachers have allowed an analysis of a large number of lessons in which ICT played a significant role. In the logs, teachers were asked to rate the success of their ICT use from negative to positive on a scale. The ratings of perceived ICT success are given in Figure 6. The commentaries of teachers on their own ratings reveal further aspects that influence on the potential of ICT in lessons.

Figure 6 Teachers' rating of ICT success



The successful ratings show a general satisfaction with the ICT aspect of the lessons. The twelve lessons attracting the unsuccessful score of seven or less were reported by seven different teachers. Their logs suggest a mixture of reasons for relative disappointment. Technical failures were not that common - only three lessons were judged this way.

One matter of popular concern in lessons where students had personal access to ICT was the potential for distraction. This was frequently identified as a management challenge but rarely identified in these logs as a 'success' issue. Only one teacher in the low-success group reported distraction as an issue. Other reports from this group either reported relative disappointment due to lost opportunity or the need for fine-tuning the use of technology to meet varying student needs.

2.6 Concluding note on teacher log analysis

In analysing these logs, two themes have been stressed. First, a systemic perspective is required whereby the intrusion of a technology into an educational practice can disturb the balance of that practice in complex ways. The metaphor of an ecosystem was encouraged as a device for thinking about this balance. Second, a mediational perspective on technology was adopted here. This invites thinking about ICT as a resource that exists as one of a number of *tools* available to support a learning practice. However, while the impact of ICT may be measured and celebrated in terms of these piecemeal roles, it is also important to identify emergent properties associated with ICT use when that use becomes pervasive. Such circumstances were increasingly apparent in these schools as they experienced the integration offered by learning platforms and the ubiquity of lesson access arising from netbooks, laptops, and computer suites.

These examples of impact are not impacts in the traditional research sense of influences on measures of attainment. However, they identify forms of impact on the *learning experience* itself. There is every reason to hope that this enrichment will be manifest in measures of achievement. However, that is an evaluation that needs to be done – albeit one that is based on monitoring the kind of inputs that are discussed here.

3 Emerging themes: contextual factors and impact on learning

The sections in this chapter draw on interview and focus group data from all phases of the project. These include preliminary interviews with teachers and managers that set the scene for the study and teacher log data that chart the impact on learning at classroom level. The teacher interviews provide a broader contextualisation of the lesson logs. They reframe the logs within a richer analysis, including the teachers' own accounts of where the lessons fitted within their developing use of ICT over time.

These perspectives, augmented by the observations of student focus groups from each of the schools, illustrate the perceived impacts of ICT on individuals, teachers and schools. We have tried to highlight where ICT has supported collaboration and communication effectively. We have also tried to map some of the unexpected pathways of opportunities that a particular application might reveal as a product of its use in different contexts.

In Chapter 2, we looked closely at the impact of ICT on learning at the classroom level. We did this by focusing on the learning practices within 85 individual lessons. In this chapter, we broaden the lens, drawing on the 98 interviews with the teachers whose lessons we analysed and with the senior managers in their schools. We also draw on 13 focus group sessions that were recorded with Year 8 and Year 10 students in six of our nine schools. Half of the teacher interviews were conducted before, and half were conducted after the lesson log exercise. Between them, these interviews provide a rich basis for understanding something of the learning environment of the schools. In particular, they help us understand the evolution of ICT use within those ecological systems.

The research team was asked by Becta to provide 'explanatory case study' evidence on the relationship between ICT and achievement. As a key part of this, we provide case notes in Appendix III of this report. These case studies are based on the interviews and lesson logs of six teachers. They give teachers' professional histories and offer examples of ways in which individual teachers have become skilled and effective users of ICT for developing learning. In this chapter, however, we want to highlight some important overarching themes that have emerged from these teachers' lessons and those of the colleagues who also participated in the Impact 09 study. We have used the metaphor of ecology at a number of points in this report, and we believe that it is valuable in emphasising that if we want to study how ICT changes education, we need to look beyond individual pieces of software, or even individual teachers. We need to look at the impact of ICT on the whole ecosystem of

schooling, highlighting aspects of teaching and learning that have emerged from looking across the project, across classrooms and across schools.

In our view, the technology-enhanced learning practices that we have observed are best understood by considering the ecologies at macro, meso and micro levels.

- **Macro level:** we take account not only of changes in the infrastructure, but look at why some institutions' large-scale change has been embedded more successfully than others.
- **Meso level:** we look not only at curriculum change, but at the ways in which successful schools are integrating curriculum change using ICT. This includes using the technology as part of assessment, out-of-school learning and personalisation.
- **Micro level:** we look not only at how ICT can affect motivation and engagement, but at how it changes the nature of learning.

These 'emerging themes', therefore, are central to our story. They start from the teachers' own words and practices and link together to provide a detailed account of the conditions under which ICT practices enhance learning, become embedded and become transformative.

Establishing a causal relationship between ICT and school achievement is problematic. However, within the ecology of schools, one causal relationship is firmly established: the link between a sustained, evolving management vision and the process of embedding the use of technology across the institution. As Davis and Somekh argued in their landmark studies of ICT in higher education (Davis et al, 1992; Davis, 1997; Somekh, 1998), it is impossible to bring about deep and embedded change unless the senior management is actively leading this change. Of course, we met many wonderfully creative teachers in the course of visiting the nine schools involved in this project (some of whom tended to work in ways that were independent of their school's ICT policy). However, it is also the case that we found no school in which ICT was embedded institutionally that did not have a headteacher who was actively leading this change. The reasons for this are transparent. In order to get ICT deeply embedded within an institution, there need to be significant changes, not only in the ICT infrastructure, but also in the finance, staffing, professional development, curriculum, assessment and models of pedagogy that are constituents of the ecosystem of the school.

Sections 3.1 to 3.6 explain each of the emerging themes (Themes 1-6). Section 3.7 discusses the themes as a whole and offers some conclusions.

3.1 Theme 1: Evolving visions, aspirations and goals

All the schools involved had leaders with vision although they did not necessarily share the same vision. In School 3, for example, the head had inherited a situation that needed urgent remedial attention:

... So the plus side was, you know, there were lots and lots of things to put right, but I knew exactly what to do... The lessons were pedestrian, they were, because the children here are very biddable, teachers got away with delivering mediocre lessons. (School 3, Headteacher)

In this case, the headteacher's vision from the outset was to use ICT as an agent for improving standards:

I knew... we needed to energise the lessons. We needed to make them more interesting, livelier, with more pace and variety... I knew you could do that through the intelligent use of ICT and interactive white boards and so on... Bearing in mind I was the twelfth headteacher in twelve years, and when I stood up and said... 'We're going to become a centre of excellence of ICT,' (there was no ICT in the school) ... they thought I'd lost the plot. But I knew... that's what we were going to do. I didn't come here to like sit around for five or ten years, just to maintain the mediocrity. You know, I'm not interested in that. The kids, 30 per cent of kids were leaving with five A-Cs. This year, 80 per cent will leave with five A-Cs. And, over six years, the school's GCSE rate has improved from 30 per cent to 80 percent. And now the goal is even higher... (School 3, Headteacher)

The headteacher's vision for using ICT to transform achievement included strategic planning as well as setting global goals. His strategy touched every aspect of the school: finance, staffing, staff development, curriculum and assessment. However, ultimately everything was focused on achievement:

... call me old fashioned, but I think that's really what we're here to do, because 80 per cent of children this year have got life chances that five years ago they wouldn't have had. We are going for 100 per cent [of pupils getting 5 C grades or higher] because they've got to leave here extremely well qualified. Because if they're not, they've had it, haven't they, really? And everything that we do and all of the kit and everything else that we buy must have an impact on that. (School 3, Headteacher)

In School 6, by contrast, the emphasis from the outset was on the ways in which ICT could inform teaching and learning, and make learning itself more meaningful and transformative. The heads in both schools were keen to encourage better teaching

and keen to raise achievement. However, from the start, ICT emphasis in School 6 was on increasing engagement, motivation and enthusiasm for learning. School 6 embarked on a route that embraced new modes of learning, and the headteacher's vision and provision of resources led to the school becoming an early adopter of an infrastructure that included a learning platform. This emphasis, in turn, evolved into a policy of adopting laptops, and more recently notebook computers. Here, the vision trajectories of Schools 3 and 6 begin to merge, in that more recently the headteacher in School 3 aligned the school's attainment goals with the 'widening access' principles of a learning platform:

...Children are in school for 15 per cent of their time and we can control that by and large. But for me, the real learning gains and the...almost untapped potential to use ICT to affect the other 85 per cent of children's lives and parents...It's just a fascinating way to engage children and parents. I mean, parents want to help their children. They don't really know what to do or how to do it. So, you know the potential for after half past three is massive and that's what we're working on at the moment. (School 3, Headteacher)

It is worth considering for a moment how headteachers acquire their vision and help evolve that vision over time to drive and energise change. In the case of School 3, that impetus came, as it has done for many headteachers, from the National College for Leadership of Schools and Children's Services (formerly NCSL) SLICT course:

I think one of the highlights for me personally was to go on the...SLICT course...I thought it was the most amazing thing I'd ever been on...By the end of it I had a strategic vision for ICT...I really understood and started to get excited about the possibilities. (School 3, Head teacher)

We shall return to the issue of staff development below. However, it is important at this point to emphasise that headteachers differ not only in the nature of their vision, but in their capability of turning that vision into a reality. We asked School 3's headteacher how many students were using their learning platform for out-of-school learning, and his answer was confident:

All of them. 900. We know that. We also [know] that if you set the traditional homework, for example, in science, you get a 50 per cent return. If you set an online homework, you get a 99 per cent return. (School 3, Head teacher)

By contrast, in another of our schools, although the headteacher spoke confidently about the importance and use made of the school's learning platform, the data on use told a different story. One of the teachers made this clear in an interview. The server log data showed that only one teacher had logged on to the learning platform during the past two months, and only three per cent of students:

I have to be perfectly honest with you here, it is all very well and good, but the giveaway is that if I show you the participants list (which is a very useful thing for teachers because it tells us who has used it and when)...apart from me, the last person that used it was 66 days ago...Daily logins on Moodle (Moodle is compulsory for all subjects across the school), daily logins are about 30 and [there are] 1200 of us... (School 5 Teacher 2)

3.2 Theme 2: Developing an infrastructure to enhance out-of-school learning

With all schools now encouraged to provide increased access to learning outside school, and to use ICT to engage parents (Becta, 2009), it is increasingly important to establish a learning platform and be clear about how it is to be used, by whom and for what purposes.

Both staff and students perceive that the multiple points of communication within the home can support the effectiveness of homework and learning outside school. The school's extranet facilities can provide learning platforms that have student management tools, such as independent learning databases and online timetables, with direct links to lesson resources. These tools facilitate learning in that they permit effective sharing, saving and retrieving of work.

Another facility that strengthens links with the home is email communication between teachers, students and parents. Students having their own personal laptops can establish further links with home learning. Although these are all different types of applications and functionalities they serve a common purpose. They enhance communication, enable more effective access and help students to organise homework. Teacher 1 in School 3 perceived that new opportunities for continuing learning from home are enhanced via the school's learning platform:

It's got to be with our independent learning, it's got to be the steps that go past what we do, what the kids do at home. When I first came in, the kids would not work at home, you'd get next to nothing off them. For homework stuff, they would do it but anything that was 'OK, you've got a test tomorrow, it's your responsibility'...they wouldn't do it. But now, they know they've got this constant access to the school. (School 3 Teacher 1)

Likewise, students perceive accessing school files from home as a crucial aspect of their learning. Students in Schools 3 and 5 commented on their school's facilities:

So if you are at home, it is just like [being] at school, our parents love it...There is a system like an online timetable and teachers upload documents from the lesson and

you can see the lesson – you can see that from anytime or anywhere. (Year 10 students in School 3)

... In IT last year you could find all the information, everyone can access that information. You can access it from home. You can save documents...on the school drive remotely. (Student in Year 10 at School 5)

In Schools 5 and 6, a 'one laptop per student scheme' establishes continuity between school and home. Having all the information on their laptop makes it easier for students to access schoolwork. Students said that it was easier to continue working as the laptop had all the things they needed for homework:

It is in your laptop and you can carry on working on it from home and also through the online database for independent learning. (Year 8 student, School 6)

At home we do most of our homework on the school laptops. (Year 7 Student in personal laptop pilot scheme School 5)

The vision of informed teachers is important in this area. This is because individual teachers often have ideas about the tools that they want to use that will be part of the infrastructure of the learning platform. They know how they want the learning platform to be used, as this teacher's comment demonstrates:

I would like to store more things other than...more PowerPoint's, notebook, Word documents or links. I would like it to have more things like film clips. I would like to get the students to be producing more things like podcasts. Actually it's becoming more of a social network site. I've encouraged the use of a forum for recording ideas about improvements in teaching and learning in English, which did get some response last year (in 2008). But you really have to push it and really drive that forward. Also, getting them (the students) discussing things like the papers for the exam outside of the classroom, and record[ing] some of those conversations to show understanding...(Teacher 1 School 1)

The teachers in School 1 emphasised developing work that was related to the end-of-year exams by using technology to increase reflection, production and critique. They wanted the learning platform to be a vital and developing repository within which students could record ideas and evaluations throughout the progress of their projects. The teachers visualised podcasts and blogging as part of this function.

In School 6, the development of the learning platform was closely linked to its goal of providing one laptop per student. The enhanced provision of one laptop per student entailed changes to lessons and schemes of work. It has led to greatly increased use of technology for learning and far greater integration of the school's learning platform

during lessons and from home. This scheme has been rolled out to incoming Year 7s for the past three years. It has also become a driver for change in how lessons are delivered. The scheme has so far reached the Year 9s. In the near future, the upper years in the school will be transformed through the laptop scheme. The experience of School 6 echoes the point made earlier in relation to School 3. This is namely that changes in the infrastructure become embedded only when they affect curriculum and assessment structures, as well as teachers' and children's hardware.

In School 1, the teachers are on this pathway. Two of the teachers from whom we collected logs recognised the need to develop the learning platform to make it more complete:

I think my mind is more preoccupied with the new sort of provision in Year 10. We need to be ready to have this sort of access. My priority is to make sure that there will be adequate provision for Year 10 and 11. (School 6 Teacher 2)

Ideally, all learning resources would be stored on there for students to access at any time, which would help when students are off sick or wish to look back at earlier sessions. (School 1 Teacher 2)

Both English and Art are prime examples... We would like to have some sort of gallery of work (online), where we can show either the students' final products or their processes, whether that's a piece of creative writing, whether it's a Movie Maker advert, or various things like that... Perhaps further examples could go onto the... [learning platform] because they would have to get access via the school in order to go onto that. But certainly some of the examples could go onto the website, which parents, or anyone could access to get a feel for the kind of things we are doing within school. (School 1 Teacher 1)

3.3 Theme 3: Staff development, the role of CPD and the role of students

As the interview comments above suggest, significant structural changes involving ICT have a massive impact on the training needs of staff. The interviews revealed a number of parallel institutional approaches to staff development as well as unexpected opportunities that played an important part within the ecologies of individual schools. In the main, staff development opportunities in the project schools placed a major emphasis on in-service training days and one-to-one support. Most of all, they stressed the importance of sharing good practice in the school with other colleagues via more or less formal communication channels. The excerpt below from School 3 illustrates an approach that was effective in spreading and sustaining good practice. There was a good deal of formalised support, but from the start, the

provision took account of the fact that individuals were at different stages in terms of their personal development:

I think we differentiated it at the outset in terms of training for people. There were very few mass briefings, you know, it was very much individualised. We ran sessions for less confident people. We ran sessions for more confident people. We got [the] more confident people to train less confident people...[There was a] sense of feeling that we're all in this together. I think the sense that I managed to convey to staff [was] that 'OK, I'm no expert. We're going to take this at a pretty slow pace. It is going to be very interesting, it's going to be fascinating for the teacher, fascinating for the kids, but we're not expecting you to be a genius by Christmas, you know'.
(School 3, Headteacher)

The interviews with teaching staff reveal additional sources of development that are less visible and sometimes even unintended. Some opportunities emerged from the alliance between teacher-student-technology that was perceived by some teachers as opening additional channels of teacher development as well as learning opportunities. These were often described as organic and spontaneous. The example below reveals an interesting interaction whereby the teacher learned from the students. This, in turn, gave space to more student participation in the classroom:

How's it changed my teaching? Drastically. We teach one another now. I mean, you put a child on Photoshop. That software normally has five or six different ways to bring about a solution. They'll find them all. They'll teach me new ways. I'll teach them the way that I know, and they'll come up with different solutions all the time. So it's absolutely fascinating. They'll learn from me, I'll learn from them. (School 3 Teacher 2)

In School 4, another teacher talked about using a film and moving image-editing package to teach poetry to a Special Education Needs group (SEN):

No. I didn't know how to use it. And I had the SEN group last year, the Year 10s, I just said to one of the boys 'Does anyone here know how to use...' and he said 'Yes, I do. I'll show you.' And he taught me...So he taught me how to do it and he taught the other boys in the class. I didn't know what I was doing. I kept saying 'What do I do now?' and he would say 'Do this and do that.' And then because he taught me, I taught Year 9 this year. But a lot of the kids already, you say to them 'Who doesn't know how to do it?' and they'll go 'Oh no, I know.' They all know. (School 4, Deputy Headteacher)

As teachers become more comfortable with the awareness that students are going to teach them, their contributions can be smoothly integrated into the fabric of the lesson:

...So a student may well find a new way of doing something or make a discovery that they've never come across before...What I would do then would be to use our [screen monitoring] system so that the child can then take control of my interactive white board and speak through the process and show everyone else in the room what they'd done. That can then be passed over to the rest and they can attempt something similar...I've been teaching now for 30 years and of course I was the person at the front of the room who more or less told children what to do. That is no longer the case. I quite often like sitting back and watching people working with the software intuitively. I love the way that a problem may arise and I do encourage them now not just to ask me what the solution is, but to find someone else in the room who has worked through that problem, so they can tutor one another... (School 3 Teacher 2)

In addition to enhancing student participation during lessons, the introduction of technology and staff development transcends the mere learning of how a tool works. Teachers revealed self-development in understanding the intricacies of how the tool linked to further learning possibilities. In the example quoted below, using students' own mobile phone cameras has resulted in new opportunities for students to take their own pictures in preparation for a digital art project. This resulted in the opportunity to explore notions of angle and perspective in photography. This was an opportunity that was simply not possible a few years ago:

...Yes, and they wouldn't have had the choice. This time around, they pick up their image of the school from Moodle and then take another photo themselves. They...[can] change the viewpoint...Four years ago we would [have given] them the picture because digital cameras were really expensive still and parents would not allow them to bring cameras in...We would have given them the photos to draw from...and that would have been it ...But now they are deciding on the viewpoint, and now they all have cameras on their phones, so it was such an easy thing for them to do... It is just a whole revelation. It is easy for me to do. They personally have their own gear. They all have access and they...[can] just take a picture. [Now] it is a whole different world...What they have nowadays...They are born into this world with these things...We have had to learn this. (School 6 Teacher 2, Art)

3.4 Theme 4: Redefining learning spaces – the boundaries of impact

The use of space is largely determined by infrastructural and subject demands. However, as we saw in the teachers' lesson log accounts, space was an issue that

was at the forefront of many teachers' minds as they discussed their pedagogy with us. Most of the schools with which we worked have started to incorporate flexible learning spaces and these are perceived to accelerate the pace of learning. Often such areas are used for ICT and non-ICT work. They are also used to promote differentiation and student-led learning. Most teachers have a default classroom layout in which the students face the front of the classroom (or the teacher). This is mainly determined by the need to attend to the interactive white board, but also for monitoring student behaviour. Sometimes students might be in clusters of tables, but still face the front. The interview excerpt below illustrates how the 'face the front' default layout acts as a constraint:

The one that's in a classroom, just an old classroom...is a traditional set out for teaching, where you have the board at the front, even though it's an interactive whiteboard. You can have children in rows sat facing the board... We do an awful lot of work in maths from the board. It's always constantly looking at the board. Here's an example: someone's asked a question, I need the board to show... so it isn't really practical to have them facing any other way. With the size of the room, you've just got to have them in rows, so it's both constraints of the room and the other way we have to look at it is the amount of questions and the amount of stuff I have to do at the front. (School 3 Teacher 1)

Flexibility and versatility of the space are the features most desired by the teachers we met. Most teachers commented on the need for larger spaces and the possibility of reconfiguring layouts easily in order to have different types of work areas. Teacher 1 in School 7 commented on the suitability of spaces that meet these criteria:

I find it fine in here because there's plenty of space. It would be preferable, perhaps, if there was another line of network computers down this side... And then you've got a wonderful big space that you can use there. I also find these tables very good for group work as well as small group discussion. You push them together... In many ways, it's ideal, I think. In this block, because you've got fast internet, you've got networked computers accessible. You've got comfy chairs. You've got big desks; you've got plenty of space. (School 7 Teacher 1)

In School 2, Teacher 3 described a diverse layout within the classroom that provides both dedicated space for computer work and a non-computer area. This fitted in with the need for both practical application and non-ICT work for planning elements of topics. This allowed movement within the room and increased the range of activities (such as using small video camcorders).

However, in the majority of cases, although many teachers wished to have it, they found access to this type of space limited or nonexistent. Nevertheless, there was a

strong and consistent perception that versatile spaces would be instrumental in providing a more diverse learning experience. Teacher 3 in School 7 expressed the same view: that having a computer area and a non-computer area would help her to direct different students to activities according to their needs during maths lessons.

Other spatial dimensions were perceived to impose limitations on the possibilities of teaching, such as the absence of wall displays. Having multiple screens around a classroom, would create further possibilities for teachers. Two different teachers in School 3 commented on this:

Oh my ideal classroom. I've actually seen it. They have the whiteboard just like we have, but then they have LCD screens around the classrooms as well... They put different things on to different screens. So, I think I'd like a computer system where you could have...multiple feeds like my friend's got on his home computer. He's got four screens banked on top of each other and your computer [could] have four video outputs and you decide which goes where. (School 3 Teacher 1)

I'd have fold down tables on the walls so that if you wanted to have just an object or a piece of information, they could be over there. Or, if they were doing an activity where they had to look at something, go back to the group and draw a piece then take turns to build the picture up as a group. Then you could have it spread around the room. If I had laptops, then you could pop them on there so they could walk over, type up, rather than them being dependent on me to find the answers, for them. [It would be great for them] to realise that I'm a facilitator to provide them [with guidance] and then they go and find the answers. I've done my work when I walk in [and] keep reminding them 'Your lesson's done. It's time for you to work'. And to have the flexibility of where things are would be brilliant. (School 3 Teacher 3)

3.5 Theme 5: Impacts of ICT on learning

In our view, there were four principal ways in which technology appears to have an impact on learning through what may be termed 'emergent' properties. These four impacts are differentiation, inspiration, coherence and engagement.

3.5.1 Differentiation

As illustrated in the 'engagement' discussion below, differentiation – and, more generally, the personalisation of learning – was the most striking theme in teachers' accounts of how technology had an impact on their practice. On the whole, the technology was regarded as an asset in helping teachers pay attention to variation in the demands and needs of students. However, there was also awareness that the technology could itself be a source of those differences:

The variation between the groups was huge...It wasn't my intention to develop their use of those particular two programmes. I was mainly interested in their research. [I wanted to know] how they used it and how they put the information across and how usable it was and the content. But their variation in the end made a massive difference...[Although] I had done mixed groups...some groups were just so much more ICT literate. They were just much more able to access it and know what they were doing more quickly. While for others it was a very slow process...and therefore it slowed them down. (School 2 Teacher 6)

This teacher is reflecting on groups of children who composed a product where they were all clear about their ideas and needs but differed in their confidence with the ICT tools. This locates ICT as a *source* of individual difference rather than a solution. While it was not commonly spoken of this way, the example is a reminder that over and above formal ICT instruction, students may enjoy different personal histories of using the tools – both in and out of class. As far as the sources of in-school variation of experience are concerned, there will be value in monitoring classroom practices in order to minimise differences of confidence.

However, ICT was more commonly identified by teachers as a support for managing learning in a way that helped them effectively respond to different student needs. This support is sometimes related to the ease with which individual progress can be monitored in certain instances using networked technology:

Some will want to get on quickly and some will wait for guidance and when you do stop them you are able, with the monitoring software, to blank the screen and you can do it straight away. You are not waiting for them to stop tapping or whatever. (School 2 Teacher 3)

In this case, ICT can serve as a medium, making students' working surfaces available to the teacher. This must create richer openings for intervention.

Otherwise, differentiation can be achieved through means that might be termed 'orchestration'. That is, teachers can exploit design features of the ICT tool to structure the nature, order, or pace of students' tasks. In the following example, the mechanics of writing on a computer are identified as a useful leveller:

I think it supports the students that are less able literacy-wise. In terms of a child who has poor handwriting or [who] really struggles, the child...can access the keyboard. Suddenly they feel so much more confident...Right now I have a much lower ability group and they just seem more confident. You put a pen in their hand and they say, 'I can't do this'. You sit them in front of a computer and their whole confidence level changes... For them it's being able to feel they can do a good job... (School 2 Teacher 6)

This is clearly empowering. Of course, the less confident child will still need to become more fluent with traditional writing tools (not least because they are likely to be assessed in that medium). However, this is a challenge of managing transitions and clearly ICT is an asset in this sense.

Teachers may also exploit design features of ICT in order to orchestrate differential access to various learning tasks:

I can pre-set five different versions of the same piece of music and they can choose which level they are going to work on. So, in terms of differentiation, it's really helped. That has helped with the engagement and the behaviour, while before I was giving out the whole range and telling some of them they only had to work on this easy bit. Some saw that as rubbish and others would say "Oh no, I can't do that can I?" So I say to them all now, start at level 1. And then they can close that down and go on to the next level. (School 2 Teacher 4)

Alternatively, the same orchestration might be managed at the pace at which an activity is to be carried out:

There was this self-regulating PowerPoint for each screen that would be set up with a load of activities. [The software] would relate: 'Now write this in your book' or 'Work out this exercise and then copy it in your book'. But they could all work at their own pace, which is just a godsend with such mixed ability. Because when I'm stuck in my [no network] room now, we've all got to work at the pace of the slowest person. (School 7 Teacher 5)

In summary, a prominent impact of ICT was identified in terms of the opportunities it creates for providing differential attention to students or for placing customised demands on them. This is because the technology could offer a less daunting interface into basic activities. In the case of networked computers, these enabled individual monitoring and effective orchestration of individual work patterns.

3.5.2 Inspiration

The idea of 'inspiration' is an emergent feature of ICT impact. However, this term is not intended to simply refer to the frequent occasions when students are inspired by their ICT-led discoveries, although these are real enough in this data:

I said 'But I'm presuming a lot of you have been on Google Earth and have seen that', and half of them had never seen it. So I called it up...and I was sticking their postcodes in and their houses. They would go 'Oh, wow'. They were almost hysterical. (School 7 Teacher 5)

Various lively sessions of map work arose from this student discovery. On the other (expressive) side of this relationship, there is also a kind of inspiration that arises from what students *do* with the media (rather than the inspiration that arises from what it shows):

Some of the work that pupils do when you step back...has been absolutely breathtaking. (School 6 Teacher 1)

In this case, the teacher also enjoyed some of the inspiration.

However, there is another form of teacher inspiration that is of even greater interest in characterising the generic outcomes of adopting ICT. The examples that emerged from our discussions were centred on the ready-to-hand nature of the technology. Typically, these examples took the form of reflecting on the state of an activity and seeing the potential for enrichment that ICT affords.

For instance, this might arise through two previously independent classroom activities suddenly becoming creatively linked. In this example, previous work with sound recording (through the application 'Audacity') was linked with stimulating students' reflections on learning:

So one of the good things that we have started using is Audacity, and they are recording what their thoughts are. So again the students can access the APP [Assessing Pupil Progress] grids because they are just talking about what they see in front of them...At the end, they were able to say they are...on this level...and this, and through just having the headphones and the mikes - they just loved it. (School 2 Teacher 3)

Another sort of teacher inspiration can arise as a by-product of what students are doing. That is, it might be something that was not part of the planned activity, but once surfaced, becomes a useful discovery. For instance, an exercise in filming music performance inadvertently revealed the ways in which different sounds might blend or compete – as students struggled to record a credible overall balance:

Having discussions along the line [of] 'Look, in order for this not to sound distorted, you have to consider where you have to be. Is your voice sounding bad at this point?'...We were dealing with musical elements in that sense - in terms of performance - in a different way than you would in a standard form. (School 5 Teacher 2)

Finally, ICT may be a source of inspiration for the teacher by virtue of the ways it can enable teachers to improvise. The teacher below discusses how accessing images and videos provide unplanned responses and takes the class discussion forward:

... Just standing at the front and communicating with the class in real time...PowerPoint...is still good for prepared stuff, but for what you're not expecting to come up and answering questions..., it's really good for that. (School 3 Teacher 1)

In summary, investment in ICT as part of routine class activity offers unexpected sources of inspiration. This inspiration has an impact on learning interactions in ways that are often serendipitous for the teacher. It is more widely acknowledged that technology can inspire students, for instance by enabling them to make their own discoveries. (It can also sometimes equip students to be sources of inspiration for others.)

3.5.3 Coherence

Celebratory discussion of ICT in learning often focuses on some particular form of learning activity that is being supported. This might be the representational versatility of multimedia, the simulation of abstract processes, and so forth. However, in analysing these 85 lessons it was apparent that learning interactions were not so neatly parcelled up. Indeed, it seemed that one important emergent impact of ICT was the capacity to create forms of coherence in learning. Coherence can take three particular forms:

- **Co-ordination**, whereby distinct activities of learning are integrated
- **Continuity**, whereby distinct episodes or sites of learning are integrated
- **Community**, whereby ICT is used to mediate the links between different people, their interests or activities.

Co-ordination

The possibility of activity co-ordination arises quite simply because functionally distinct tasks (in terms of learning goals) are executed in the same working space – that is, the networked computer desktop. While this convergence of activity to a single site is at the heart of this form of coherence, it also can be a source of difficulty for teachers. This is because students can easily stray off-task into activities. In the example below, the teacher is recounting how the network laptop offered a variety of distractions to the core task of music composition:

They could be completely zoned on the laptop and missing everything else going on around them. That was the key frustration. As they got into this world, they failed to separate that it's a music lesson. 'We need to compose music. We are just using the technology as a tool to help you do that.' (School 5 Teacher 2)

However, to neutralise this problem, we found plenty of examples where the multi-functional nature of the technology allowed rich co-ordination of tasks – often involving projects of production or performance:

ICT was at the very heart of this process: digital collection of imagery; online research; digital manipulation of images; digital printing and upload[ing]... (School 3 Teacher 2)

In the case below, a music teacher defused the self-consciousness of live performance by allowing some students to make a video around the performance aspect of their composition. They co-ordinated video production facilities on their laptops using the music composition software:

A lot of them have had limited previous music education in primary school, particularly their exposure to live performance and many find that format of presenting that work initially a tricky thing to do... taking that live performance out of the scenario and giving them the opportunity to explore film or audio seemed a little bit of a leveller...with film they had an opportunity to refine it and evaluate it as an audience would see it. (School 5 Teacher 2)

In these cases, teachers took advantage of the co-ordination made possible by a convergence of tools at the single point of a networked computer. On other occasions, co-ordination was achieved by technology being used in an activity that previously did not involve ICT. Such examples demonstrate the potential of the technology to create coherence by co-ordinating the components of a task:

Last week they had a myriad of different things they had to get done in a short space of time and multiple things going on at the same time so they had to split up around the school...To keep in contact I said they had to think how to do that. So they set up wikis...[that way] everyone could enter their material and not constantly email. Because they couldn't use their mobile phones, they had to think of another way of doing that. (School 6 Teacher 1)

Perhaps the most straightforward and common example of technology enabling co-ordination is when it is used to link lesson activity with assessment feedback. Students can readily email their reports to teachers, who provide feedback within the documents sent:

...now they all know how to attach something in an email and it means in terms of the time in a lesson you can go right to the end of a lesson pretty much. Then they attach to an email and send it to me and then I can sit and mark it in my own time. (School 2 Teacher 4)

Continuity

The second form of coherence encountered concerns the creation of continuity between different episodes, occasions or sites of learning. It allows learning that might otherwise seem fragmented to gain a temporal form of coherence. This possibility manifests itself in various ways; to some extent these are distinguished by the time scales involved. For instance, some forms of continuity concern refreshing memories from one lesson to the next:

Only 5 years ago, if we were working on a composition we would be using electronic keyboards, the students would spend the lesson working on the ideas, they would write them down in various ways but always when you came back to it next week there would be at least a 10 minute, 'Oh what did I write down there?' and 'I can't remember things'...Now it's instant. You can listen to what you did last week and off you go. [You can] even say, 'That's rubbish. I want to start again'. But that's fine. I think they are therefore making much more progression. (School 2 Teacher 4)

Also, a piece of work might be re-visited much later in a course of study:

The class work produced will be used at a later date, as a form of electronic revision material. (School 4 Teacher 1)

Relating to students' own views and experiences using... [an online political quiz] made the material far more relevant. It also provided opportunity to revisit how their views have changed at the end of this unit. (School 7 Teacher 1)

Related to this is the developing practice whereby work that might be seeded in a single lesson is encouraged to evolve through the interests of the students themselves. Few examples of this were evident but it is clear that learning platforms and other shared spaces allow this to happen. One example that was encountered involved using Google Maps as a site for students to update and develop a shareable personal travel history:

Ideally what I want them to do is, throughout their school careers, every time they ...visit a place, they enter this into Google Maps. (School 5 Teacher 1)

Another reason teachers gave for the longer-term retention of student work, was to create a way for a class to 'leave tracks' of their activity. Such archives were seen by some teachers as a way of launching the work of later classes, or giving them a chance to see the efforts of those that came before them:

Then I save the compositions to my own area, so I have a record. Whereas before I always talked about recording them onto tape but you just didn't get round to doing

it... Now I have some material from...classes I have taught for three years and I can go back and listen to what they did in Year 7. (School 2 Teacher 4)

What I've now got, I've got a bank of good and bad examples from last year that I will show them before they go away to do theirs. So it is a developing thing. (School 7 Teacher 5)

To some extent, the examples of technology creating continuity can be seen as a practice that erodes some of the walls around the traditional classroom. This might be made explicit by the increasing use of electronic communication or by the development of a class presence on the school learning platform:

I see my website as my classroom, and my classroom is now accessible to my students outside the hours of the school. (School 7 Teacher 1)

Yes, a few had difficulties, but we managed to address these. Students e-mailed their concerns and I was able to respond promptly. (School 6 Teacher 2)

In many of these discussions the link across time (and 'through walls') was one that involved students working at home. Evidently, the technology makes this easy in a very practical sense:

I'm learning about the problems of transferring work home in a digital format. In the past with art and design, we had to carry large folders backwards and forwards, it just didn't work. (School 3 Teacher 2)

Moreover, this continuity may work to some extent because of a perceived link between the experience of technology at home and in school:

I think confidence has got a lot to do with it... students are very IT apt at the minute...When we were asking them to come to a lesson and be talked at for a while, it's different. It's a big gap between what they do at school and what they do at home. Whereas, if you do try and relate the technology they have at home [to the] ...lesson...you are kind of narrowing the gap between classroom and home which could then lead to more interest within the class...The technology encourages them and I think it then allows them to actually concentrate on what they are actually learning... [rather than leaving them wondering] how they are going to show what they have done. (School 2 Teacher 3)

Community

Some forms of coherence can be created by using technology to link students to other individuals and to communities. This is another way of rendering classroom

walls more permeable. We found only a few examples of activities that were moving in this direction, although this approach was under discussion with some teachers:

[In] a couple of projects where we had people in from the community... the students were put in groups and they were working with certain people. They only met the person once and then didn't meet them again until the showcase at the end. But because of email contacts, the students were able to get all the information from those people. [They were able to] send pictures through for their work etc and so that worked for them... We have had students go off on...trips abroad and because of the website, they were able to upload some of their diaries and things like that. (School 2 Teacher 3)

Perhaps the more topical form of community linking is between students and family. There was little reference to this in the lessons we studied, although interviews suggested it was a topic that was slowly attracting attention. It was apparent that this form of communication was one that would need careful consideration and development. Already there were examples of how ICT practices needed to be explained to parents:

One of the concerns was geography because he doesn't have a lot in his book. [This is]... because a lot of what was done was on laptops via Google Maps. This is not a problem but it was a case of some of the parents needing to realise learning is not just a matter of how much you have in a book... I went through it and she said 'That's all right. No problem'. But a lot of parents do equate what is in their exercise book to what is learning. (School 5 Teacher 1)

On the other hand, 'family' is the most potent form of possible audience that might be recruited. For some teachers there was an interest in giving meaning to students' work by putting it online and encouraging family discussion, as well as discussion among the wider community:

I encourage all of my students, at the end of every lesson, to take whatever they've been working on to their [online] space... Now, they might simply go home and discuss that work with their parents. We also share a lot through international online galleries. We've got a web gallery on the Saatchi [online] gallery. We've probably got 50 pieces of work on there. My photographers and graphic artists share work through 'e-photozine' [on online gallery with discussion forums]. They can comment on other people's work and people can comment on theirs. (School 3 Teacher 2)

In terms of Moodle, I wanted them to be sharing and evaluating each other's work. .. equally, in terms of parental engagement, to have parents be able to make the effort and see what was going on. (School 5 Teacher 2)

In summary, an emergent property of using ICT appears to be the creation of various forms of coherence within the learning experience. The convergence of digital applications on one site (the networked computer) means that different sorts of activity can be readily co-ordinated, while the networked nature of the ICT infrastructure facilitates continuity between activities executed at different times. It also can support the development of informal communities around students' work.

3.5.4 Engagement

It is generally agreed that ICT enhances motivation, and particularly the motivation of boys. Research has confirmed this general association, from both the early days of ICT (NCET, 1994) and in more recent reviews (for example Pittard et al, 2003). Pittard's review is particularly relevant to the findings of this present study. It separated out a number of different effects, on which teachers in our project schools have commented. These aspects are:

- **ICT can increase engagement.** Students are more involved.
- **ICT is perceived as enjoyable.** Everyone wants to participate in activity that is perceived as 'fun'.
- **ICT can increase attention.** Without attention there is no learning. When ICT increases students' attention, this has other benefits. More teacher time is freed up for work with individuals.
- **ICT can increase students' time on task for school work.** This is one of the most crucial variables in measuring the impact of ICT, because of its potential payoff in increasing learning.

Computers are no longer a novelty in children's lives. However, as this geography teacher from School 7 indicates, it is important to avoid repetitive or trivial uses of technology:

... I found that the first couple of years that I was teaching, you got them in the computer room and they were all beautifully behaved because they felt it was a treat...Now, I think because it's so commonplace, you've got to move the bar a little bit and do something a little bit different... (School 7 Teacher 5)

This teacher made some very important points. ICT can be engaging and motivating, but it is no longer intrinsically motivating. Children need variety. They need to participate, if they are to be engaged. Furthermore, they will be most engaged if, as well as being involved in production, their critical faculties are activated. As the students themselves told us, a little competition can also be motivating:

The good thing is that you could track your progress and there was a bit of a competition between the pupils and that spurred everyone [on]. (Student Year 10 School 3)

Finally, Pittard et al (2003) also suggested that teachers should not overestimate the motivational power of the computer. Research has also shown that if students are left to carry out group 'research' unsupported, or study on the computer on their own for too long, motivation wanes. Behaviour then becomes less focused and learning may stop.

3.6 Theme 6: Exploiting the affordances of new media

ICT has mediational properties that are perceived by teachers and students to enhance the effectiveness of the learning experience. The mediational properties that teachers and students highlighted are the ability to reduce students' anxiety through anonymity and offering greater opportunities to accommodate individual needs, particularly by taking a multimodal approach.

These properties of different media are described here in relation to their affordances and other impacts on the learning experience.

3.6.1 ICT can introduce anonymity and reduce the anxiety of students

Teachers perceived a range of technological applications that can help distance students from their work, thereby reducing students' anxiety about performing a particular task. For instance, this perceived quality was found in handheld voting systems that were used for whole-class quizzes. Students perceived that these devices removed the anxiety of directly speaking to the class:

In science, we have those handheld things [voting systems]. The teachers do like little quizzes, then you have to press the letter, you choose it and then you can see if you got it right and how many you got right. They are very useful because everyone gets involved. You find out...how well you are doing so far...It is better than putting your hand up. You feel more involved. No one knows if you are getting it right or wrong (it is like playing who wants to be a millionaire and wanting to win). It is motivating and it is more fun than just writ[ing] it down. (Student Year 10 School 5)

The electronic submission of students' work can facilitate sharing. One example of this is when an individual's work is displayed to the whole class anonymously for discussion or critique. Other applications that have been found to reduce anxiety and enhance student participation in whole-class activities are the use of Web 2.0 type applications such as online blogs and forums.

Several teachers described how they displayed electronic pieces of student work and how electronic media enabled this work to be transferred quickly and anonymously. In one example, students emailed their music composition pieces (projects) to the teacher where this work was stored (allowing it to be played back at any time). The teacher played the pieces to the class without revealing the identity of the student (School 2 Teacher 4). Other teachers (School 3, Teachers 1 and 2) have highlighted similar examples in maths and arts teaching.

Below is an excerpt that shows how using Web 2.0 technologies can enhance whole-group discussion. These technologies can also help overcome some of the problems that might be experienced in a face-to-face environment:

...everyone gets an equal amount of say, whilst in a verbal discussion quiet people are shouted down. They don't get their points of view listened to, whereas no one will sit at their computer flaming everyone who has an opinion that is different to theirs. What I find exciting is that a discussion will go on for three or four days, or a week, as opposed to ten minutes in a lesson. So people will say something and then... reflect about it. Then they return and say, "Actually, I have changed my idea about this..." So once again, if you try to match that to Bloom's taxonomy, you...get to the analysis and synthesis that are at the very top of the tree, because they are synthesising and you allow them the time to think things through... (School 6 Teacher 1)

3.6.2 Multimedia offers augmented pathways to learning

Broadening the range of media used in teaching is not simply about enhancing motivation; it is also about learning and the cognitive benefits of using ICT. In simple computational terms, digital images contain much more information than a text file (a single image on many camera phones contains more data than the entire King James Version of the Holy Bible). Teachers told us that they had switched from using text-heavy 'death-by-PowerPoint' presentations to providing information in a variety of media. This variety includes text, images, video, animations, sound files and virtual reality. Teachers aim to present their students with as many learning opportunities as possible. As Ainsworth (2008) points out, there are different types of cognitive process that may be assisted by viewing multimodal representations. However, the whole area is complex, under-researched and characterised by over-optimistic claims. Nevertheless, a range of studies has shown benefits in learning from multiple representations. This is in relation to increased motivation and engagement, associational links with other learning and better understanding of complex processes (such as weather patterns or the cardiovascular system).

Many of the teachers with whom we worked were using multimedia, but we have selected an example that demonstrates how the use of different media may be co-ordinated, and used to enhance learning in a series of ways. This geography teacher (School 3 Teacher 3) used a variety of media within a single lesson. This was not done to simply increase attention but to enhance many aspects of learning (we have suggested the learning potential in brackets after each example):

- *For [a topic on] weather I'll usually put a little bit of music at the beginning. All of my videos are usually images and text over music, so it depends. (Activating prior knowledge; creating associations to stimulate subsequent recall)*
- *Or, I'd have little bits of movie clips that I play, like I only usually keep them quite short, five minutes. Then they've got to do something based around it. (Linking sound and moving image to concept development; demonstrating complex processes)*
- *I've got dyslexic pupils in the class and I know certain colours, what they prefer, I can have the background to that colour... The rest of the pupils don't realise that I'm doing it for certain people so it doesn't isolate... (The research data on text-background combinations for dyslexic readers is contested, but legibility research does find some combinations better than others for readers with poor colour vision. In this case, the student reported that a brown text on pale lime green background greatly improved legibility.)*
- *I also use lots of short video clips... It's things like the BBC's clips... Recently we were doing Mount Vesuvius. It was on Dr Who. And it had them going back in time in the time machine... to Mount Vesuvius. So it links in to what they already know and it links their own knowledge in. (Activating prior knowledge; increasing attention; creating strong associations; demonstrating an abstract concept in geology through drama)*
- *I rely heavily on PowerPoint... but I have to say my use of it has changed. I'm now reflecting back on what I did when I very first started teaching and it was very much death by PowerPoint. So... my use of it is changing and the fact that it is more interactive, that it's there as a support of whatever they're doing. (Using text for discussion and reflection, rather than simple exposition)*
- *It's a good way of being reflective as well, because you have something solid to look back on. [This is] because everything's electronic: the lesson plan, the PowerPoint, all the resources are done on computers, nothing's handwritten. So it's a good way of reflecting on what you've done after you've done it and it's an easy way of ultimately changing without the core content of it changing. So that's really*

important as well. (Using ICT to increase teacher and student access to multimedia before and after lessons)

Presenting material in a variety of modes does not imply a belief in 'learning styles', of course. Most teachers accept that if an idea can be reinforced in a number of different ways, it is much more likely to be remembered. Information theorists use the word 'redundancy' to refer to information that is sent repeatedly, but for most students, repetition is only redundant if the learning is already secure. In most situations, presentation in the variety of modes that ICT can facilitate not only helps to embed learning, it offers alternative pathways to learning for students with different background knowledge or different skills levels. One maths teacher explains:

...I'm very conscious of how you introduce a topic because there's more than one way to skin a rabbit, as I always say. I think a good idea is to show... [students] as many ways as possible and let them pick which... [programme] they prefer. I try to use as many [programmes] as I can but there's always another one around the corner that we can introduce...I think it would be nice if the...[students] who are having problems could get onto a computer to have it explained to them... I perhaps talk too quickly and they could work at it at their own level. At the other end, obviously, we have some students that are very quick and so extension work would be ideal for them, that they could be able to improve their knowledge even further. That's the main thing. That's why I don't want a whole room of them, I just want a couple, six [computers]. (School 7 Teacher 3, Maths)

As well as increasing differentiation, a number of the maths teachers that we met were making increasing use of multimedia for teaching concepts and procedures. They accepted that a slightly different explanation from a teacher on a video might not only be helpful, but would be accessible to the student from home:

I think stuff like watching the videos of 'Maths Watch', they enjoy it because I'll run the video through once and it gives me a break and I can sit down and wander round the class, see how they're doing, keep an eye... Then I can go through it again and they're hearing two different voices. I know it's the same thing that's being said but it really does help, hearing it a second time from a different voice... Even though I'll be talking through the same example there, they don't talk about the thinking they go through, whereas when I go through I say 'I'm thinking through this, what do I need to do next?' I think it helps having both ways and that's always there for them to go back to. (School 3 Teacher 1, Maths)

New affordances linked to visual display

Interactive white boards, high-definition data projector displays and individual computer screens all have the capacity to engage and sustain attention. Equally they can be distracting and teachers take this into account in their management of the classroom. Three examples illustrate the perception by teachers that both a large screen and individual computers can enhance attention and the ability to concentrate on a task:

The piece of equipment that's been, I would say...had the most impact is the visualiser and we got those five years ago... You can use them in such a varied way. ...if I haven't got my visualiser now to teach with, it's almost as if my right arm, I've got something missing, because I use it in so many different ways. I teach English and it used to be you'd get students to read out a piece of work and get the rest of the class to discuss how to improve it. [Now] it's all on the visualiser. You show it. So everybody can see the same thing at the same time. You can change it. You can capture it and you can actually do things to a document that students have produced. Others can suggest ways to improve it. They can sit and do it. (School 4, English teacher)

... [individual screens that show the teacher's screen] I think it helps them to focus more on their own work. They can have their own work up on the screen and they can see what I'm doing at the same time, so one thing can quite easily feed into another. It's not 'Switch off your screen, turn around'. There's a lapse there, isn't there? They've come away from what they were doing. (School 3 Teacher 2, Art)

...they are a lot more focused when they're on individual computers. I'm not really sure why. I've... [wondered] if it's because there's no one else in their line of sight. They're just looking straight to screen, whereas if they're looking at the board, there might be 4, 5 people in front of them and they might want to poke them and mess around. It's incredibly focused when you do it like that. Even if it's just me speaking, they won't look up at me... [Their] eyes [are] on the screen and [they] focus on what's being done. (School 3 Teacher 1, Maths)

The students agree that a screen provides a different kind of focus from a textbook:

...for example, like the teacher says, 'OK, now you get on with it and then you focus'. If you had to be handwriting, it would not be so much fun. (Student in Year 7 School 5)

The use of network screen monitoring software allows presentations to be on all of the students' screens. This enables the teacher to get the students' attention (when the teacher freezes their screens). This encourages students to pay attention as they cannot use their computers while this happens. This software is also effective for monitoring students' progress, since without leaving their desk, the teacher can

access any screen contents at any time. As part of this, they can ask a student to reflect on their work.

The range of different technology is vital to engage students. In this lesson (which is longer than most) it is important to break the three hours into little chunks of work, and technology enables this to happen. The selection of technologies used ranges from DVDs and video to the computer. (School 2 Teacher 6)

Using new media to augment feedback and increase the pace of learning

ICT can enhance the provision of feedback in terms of speed, range of possible sources and range of locations (inside and outside of school). Here we offer several examples that illustrate how different settings and applications facilitate feedback. A number of applications provide this information on performance. Teachers can leverage that information to provide rapid individual and group feedback and to facilitate progression.

In one of the project schools, the increased provision of one laptop per child has resulted in teachers being able to do an entry quiz for Year 7 students, using students' laptops. The teacher is able to look at results instantly and feed those back into the classroom, providing feedback to the group.

Once they [have] loaded the answers, we go through the answers with them and that helps us to move them on. We can go back and correct them. We have developed the questionnaire over the years. We would see the type of data that the questions kicked back. We moved away from open text answers. We have been doing this on the computers for three years. Before [this], it was all on paper. (School 6 Teacher 2)

The facility to manage a networked classroom in which a teacher can monitor and control every computer not only speeds, but also facilitates the provision of feedback to students in the course of a lesson. The teacher has an overview of all the live screens as students work on a task. This has been described by teachers as supporting them in identifying particular individual problems as well as whole-class issues. This makes it possible for teachers to intervene when a problem is experienced.

To start with, it is the same as what I do on the whiteboard. But as they go through the lesson and they put up their hand for help, what I'm able to do is control each individual computer. So I can either control that child's individual computer, or if I think that's a problem the whole class have got, I put [it] up on the big screen. 'Everyone look at this' or I put it onto everyone else's screens and say, 'I'll show you how to do the work'. (School 3 Teacher 1)

In School 1, Teacher 2 described a similar use as the one above, but turned feedback into a group exercise. Within the session, a remotely controlled display of students' work was used to create a peer discussion and an evaluation of peer work. The teacher displayed students' work, and encouraged the class to evaluate it in terms of selecting a good point of the work and highlighting an area for improvement. This method increased the oral feedback among peers.

Other examples relate to enhancing feedback outside the class. The teacher utilises technology in order to enhance the feedback loop. An example of this was provided by Teacher 3 in School 2. The teacher described giving students graphical planning sheets (as opposed to writing text out in full, which the teacher felt was very demotivating for students), where they could submit these with little notes and comments. Technological devices for recording spoken feedback are used by students to record comments as they go along in their project. These are then uploaded to their website. This encouraged students to evaluate their work and improve it as they progressed with their work.

Enhancing student work and pride using new media

ICT was perceived to have an impact on learning and achievement by enhancing the quality of the work produced by students in different ways. Below is an example by a student describing how he could obtain better results through a video-based project for his Citizenship work:

...we wouldn't be able to invite a teacher to our house to see it then, so we film it first. That was fun... They are going to start using it more because it works. Also you can edit it, because if the teacher was there and you made a mistake, you would not be able to take that out, but with video you can make it better and edit it out. (Student Year 10 School 5)

The introduction of video for assessment in the class was also described as enhancing the student learning for a different set of reasons. In School 7, Teacher 4 filmed students in a foreign language assessment project performing a puppet theatre using the students' dolls. Students commented on their experience of this as positive and motivating, as this focus group comment shows:

It was like last year in Year 7, we did the Olympics and we had to do it with dolls... We had to make a play. It was good...it...tested...your pronunciation, the teacher filmed it and put it on the... [interactive whiteboard]. So she would film it and we were under pressure to get it right. It was the end-of-year test – she records it... You have to try and get it right – you have to speak in a French accent. Then you listen to it, so you are under pressure. (Student Year 8 School 7)

Editing facilities in Word can also be motivating for students. An example of this was described by Teacher 6 in School 2. Technology gave the less able students support to improve literacy skills. When students had a piece of writing with mistakes they were not motivated to edit them. However, using a computer to aid writing skills gave students the opportunity to edit work, offering suggestions to correct spelling mistakes. This improved confidence among students and, from this point of view, they grew up. The word processing software increased engagement and motivation, as students had more control over document design. They also took a greater pride in their work.

ICT can create new knowledge and skills, with links to future professions

Both students and teachers perceived some of the software available in schools today as establishing links with future professions, facilitating learning that connects to developing skills that will be useful in the future. These two teachers were using commercial software that is usually not found in schools, because it is regarded as too complex and expensive:

It's industrial specification software, because...I would like these children to leave school at 16 with the necessary skills to go into a design studio, a web studio. I was criticised heavily when I first introduced [the commercial, professional edition of] Photoshop into this school and into the authority. But I think people are now eating their words. They're using it very well at Year 7. I've got a transition course coming in two weeks' time from a primary school. (School 3 Teacher 2, Art and design)

...Kids actually use, at a very basic level, stuff they could possibly use in the future, if they decide to go on to design. The...computer-aided, three-dimensional design software [is] not far off what the kids are mucking around with now in school. [It is a] different platform, different layout. There are more restraints with the software in school. But they're not far off... (School 4 Teacher 1, Technology)

Teachers and students highlighted this positive aspect of using hardware and software applications that provide skills students need for future professions:

All we do is very relevant, like things we will use in the future in a job, like we do Excel in our ICT. (Student in Year 8 School 6)

When you are older and you are going to be a businessman you are going to use it. (Student in Year 8 School 3)

3.7 Discussion of emerging themes

Elsewhere in this report we note that demonstrating the impact of ICT on learning has been a research challenge fraught with problems. To simplify matters, those problems can be expressed in terms of two issues that arise when researching the impact of ICT on educational practice:

- the availability of ICT does not imply uptake
- the value added may be more than the value measured.

Putting this another way: on the input-to-learning side, research needs to evolve close and probing measures of *use* – measures that go beyond mere opportunity of access. And on the output-on-achievement side, research needs to devise more generous measures of learner competence than those given by standard test and examination results.

In this section we summarise our own findings in relation to these two themes. The institutional focus of this study has reinforced some of the findings from previous system-wide projects such as the Test Bed project (Somekh and Underwood et al, 2006). However, our methods have extended this tradition of research by attending to the events and contexts of individual lessons. Moreover, we have engaged with schools that are relatively confident with ICT (who might be described as being e-mature). Accordingly, we present below a model of uptake that suggests a number of key factors that are driving the move from availability to use.

In the second sub-section below, we then address the matter of defining value added. Here, our observations do indicate the ways in which ICT adds value that goes beyond that which is traditionally measured in standard tests. We suggest the form that this takes and invite future researchers to develop measures to capture this with methods that may allow more quantitative impact studies.

3.7.1 Key factors behind vigorous ICT uptake

(1) Leadership and vision: The first set of issues that emerged as fundamental were around institutional structures, and we have tried to show how important leadership and vision have been in guiding these schools to a position in which ICT for learning is becoming deeply embedded, with strong links between infrastructure, curriculum, pedagogy and assessment. The Test Bed project revealed a similar set of issues and the need for strong vision from the top institutional level in implementing a successful ICT strategy.

(2) Commitment to learning platform. We noted that while all nine schools saw the importance of developing a learning platform as a key part of their ICT strategy, they were not equally successful in implementing that strategy, and we argue that having

clear goals, linked coherently to curriculum, assessment and parental engagement is an important factor in success.

(3) Sensitive staff development. We noted that staff development was crucial, and that teachers suggested that this was most effective when it was delivered in ways that were responsive to the needs of individuals, that set clear goals but did not feel threatening. We also heard from many teachers that some of their most important learning came from their students, and that students' expertise with ICT was redefining the authority of learning in their classrooms. The ICT Test Bed project also emphasised the importance of an open culture of sharing and structured CPD programmes. However, less attention has been paid so far to the role of the students in this domain, and the role of students in both enhancing teacher development but also the learning of other students – as encouraged by the 'Narrowing the gap' project (Underwood et al, 2009).

(4) Versatile learning spaces. Teachers told us that ICT was changing the ways in which they used space, and the ways in which they taught. As the lesson logs section revealed, flexibility and creativity based upon these new opportunities for interaction are becoming dominant themes in lessons that exploit ICT for learning.

3.7.2 Two forms of new value added by ICT uptake

What are the perceived gains associated with widespread adoption of ICT within individual lessons? The present project has addressed 'e-maturity' at the level of individual lessons. What is apparent within these lessons is perceived success and engagement, as well as, more generally, new forms of classroom versatility. This versatility includes new practices, which we believe are adding real value to the educational experience. We suggest that this can be unpacked further in terms of two themes: one concerned with the coordination of learning episodes and one concerned with the nature of the interactions taking place during such episodes. This first theme is summarised in terms of a finer and more creative articulation of how a learning episode plays out. The second is summarised in terms of proposing that there is a new diversification of learning interactions.

Articulation of learning episodes: Previously it has been noted how ICT is allowing greater personalisation of learning (Underwood et al, 2010). In the present research, we reinforce this at the level of classroom practices. We find personalisation, in the sense that teachers are responding to more specialised needs. We also find indications of how the technology is supporting teacher improvisation and, most notably, how it is allowing new forms of *coherence* to be created within the inevitably fragmented quality of typical learning episodes.

'Articulation' in this sense means recruiting the technology to find productive links between activities, between sites of learning, and between different individuals in a

student's wider community of learning. We believe that much of this dynamic of finer articulation is something new. In particular, it reflects the opportunities afforded by the increased portability, mobility, and connectivity of current ICT. It may not have been a factor so strongly at work in the context of previous impact studies. We would expect its benefits to become increasingly visible in future studies.

Diversification of learning interactions: This finding emerges from our investment in breaking down learning: that is, moving away from the more familiar notion of learning as a somewhat singular and abstract psychological process. On this traditional view, the educator's challenge is one of simply finding the best method to activate such a process – in order that the student may integrate some experience into memory. The more singular view relates learning too closely to memory (and, perhaps, memory too closely to recitation). Measures of its success are thereby rather back-facing, in the sense that they dwell on tests to establish that the material learned has actually been remembered. However, the alternative is to see learning in terms of a *variety* of practices (Table 1). There is no single 'best way'. So, the present more diversified model of learning (as multiple practices) is more firmly forward-facing. The learner's achievement does not now simply comprise a store of remembered content. The successful student graduates with a repertoire: that is, a set of procedures-for-learning. The learner's achievement must include confidence with a whole range of approaches for interrogating the world – approaches that allow them to learn from it. The learner's achievement thereby comprises a set of exploratory and information-systematising strategies: resources that can be mobilised in *future* situations of inquiry or problem solving. We believe that access to ICT-intensive activities is making substantial contributions to cultivating this dimension of successful educational practice.

Figure 4 Distribution of learning practices involving ICT (page 16), suggests that this form of variety in classroom experience – that is, a diversification of learning practices – is evolving under the influence of access to ICT. There is more that could be achieved. However, the present analysis invites thinking of ways to stimulate such further development.

We suggest that many of the interactions afforded within this diversification relate naturally to the content of what is sometimes termed '21st century skills'. There are many ad hoc lists of what such a skill set entails. For simplification we would summarise them in the terms invoked in an earlier Becta report (Crook and Harrison, 2008). Such skills gather around themes of: collaboration, literacy, inquiry, and publication. More specifically, they entail the following: an ability and motive to learn by integrating one's thinking with others, a receptive and creative orientation to non-textual forms of representation, new strategies for interrogating distributed and

networked forms of information and, finally, a willingness to make the output of learning visible and open to reflection, commentary, and critique.

We suggest that this mix of new approaches to attending, investigating, expressing, and reviewing are at the heart of the skill set demanded by modern forms of knowledge-oriented society. However, it must be noted that they are almost diametrically opposed to the skill set called upon for strong performance in that iconic form of educational assessment – the examination. The examination is not collaborative because performance is solitary, rather than social. It involves a narrow range of literacies because its demands on representation are largely on textual literacy. It obstructs active inquiry because it denies access to resources that inquiry skills might employ.

Finally, its output is private because effort results in a product that is largely unseen by others and often attracts no formal feedback. Insofar as output from such testing continues to be the measure of ICT impact, there is a danger that we are missing dimensions of added value that are central to the needs of modern societies. The observations of practice that we report here strongly indicate that a form of added value is present that is not being directly assessed – as has previously been stressed by Underwood et al (2010). This problem needs to be addressed and, in particular, it calls upon research that helps define useful methods of assessing student progress in these new intellectual skills and motivations.

3.7.3. Coda

It would be naïve to imply that these very positive messages represent the only learning practices in our project schools. Teachers generally selected lessons that they thought represented their best practice. It would be wrong to suggest that every lesson in these schools involved complex, well-integrated ICT, which led to impressive learning gains. But what we do feel confident in saying is that these lessons do demonstrate thoughtful and effective ICT-supported practice, and show how ICT can link to increased learning.

Implementing change can be painful, threatening, frustrating, confusing, anxiety-provoking and stressful. It can also be exciting, challenging, collegial, life-affirming and transformational. It would be naïve of us to pretend that, in a project such as this, we have encountered only positive messages. However, where we have reported tension and frustration we have also tried to indicate why this was the case, and what could improve the situation.

One of the many positives in this project was the high number of teachers who, when faced with a difficulty or challenge, had a clear idea of what would be needed to fix the problem. Many of them went ahead with their own solution, even if it was outside

the recommended procedures, rather than miss an opportunity to enhance their students' learning.

We also want to make one other point very forcibly, which is that teachers and senior managers are increasingly aware that it is no longer enough to regard the implementation of ICT as a matter for individual subject teachers or departments. Deep embedding of ICT for learning starts at the classroom level, in individual lessons, with teachers who bring together technologies to achieve specific learning goals, and do so in ways that integrate ICT into course design, lesson planning, lesson delivery, homework, feedback and assessment. And for this to happen, the deep embedding also has to operate at the system level, so that a coherent vision involving infrastructure, staff development, network management, curriculum provision, management and assessment systems and the learning platform all work together coherently to deliver 24/7 learning. This is a massive task, but it is one that all our project schools recognise as the challenge they are addressing.

4 Discussion and conclusion

In introducing this report, we drew attention to challenges arising from the tradition of ICT impact research. These arose from the disappointment expressed by some commentators that the promise of educational technology has not always been realised in the form of substantial learning gains, when scaling up from local studies to system-wide adoptions.

A particular challenge surrounds the difficulty of interpreting impact research outcomes in terms of causal pathways. To a considerable extent, these difficulties arise from the complex nature of the systems of practice into which ICT innovation is introduced. We have argued for a fuller understanding of the dynamics of that system as it might be found in current secondary education. We have also argued that attention should be paid to the manner in which teaching and learning is re-mediated by a technology that does not simply amplify the educational process, but configures it into different forms.

This perspective invites an approach to understanding impact that considers the impact on learning *practices*, rather than the impact on learning outcomes. This target not only shifts attention from attainment *products* to engagement *processes*, it defines activities in terms of *learning* practices rather than *instructional* practices. Learning is taken to be an interaction with materials, symbolic representations, or people – taking place through the mediation of tools and technologies. However, this apparent student-focus does not marginalise the presence of the teacher. Teachers remain key to understanding the process of orchestrating such interactions within classrooms. In fact, it has been the perception and experience of the teachers involved with this management and innovation that has been the focus of much of our fieldwork.

To develop useful understanding from this perspective, it has been necessary to seek schools where the use of ICT is mature and to work with teachers whose own confidence with ICT is reasonably secure. From their accounts it should be possible to gain greater insight into the ecological nature of the systems in which learning is located. We should also be able to gain greater insight into the distinctive impacts that ICT mediation is bringing about. From those observations, the following insights have arisen: it is important to note that the particular lessons that were at the focus of our fieldwork were regarded by those teachers as successful. In particular, they engaged the students and they were not disrupted by significant behaviour or technical problems.

Given the schools that were recruited to participate, it is not surprising that ICT was found to be entering a phase where its involvement with the curriculum was increasingly pervasive and, to some extent, becoming transparent. In infrastructural terms, this was evident through the ubiquitous learning platform and interactive whiteboard. It was also evident through the increasing number of lessons, in which students had sustained access to a personal, networked computer (often a laptop). In a situation of frequent and flexible use of this kind, there are impacts of the technology that we might term 'emergent'. They emerge as features that exist above the focused impacts of *particular* ICT-supported learning activities. They are re-configurations of practice that occur as a consequence of more generic forces. We would draw special attention to the following:

- **ICT makes possible new forms of overarching classroom practice.** This is apparent in three particular respects: (1) the reconfiguration of space such that new patterns of mobility, flexible working, and activity management can occur, (2) new ways in which class activities can be triggered, orchestrated and monitored, (3) new experiences associated with the virtualisation of established and routine practices – such as using multiple documents in parallel, or manipulating spatial representations.
- **ICT creates the possibility of a wide variety of learning practices.** Overarching this variety are three central activities which are significantly enriched by the ubiquitous availability of technologies: (1) exposition, which is animated by the opportunity to invoke rich shared images, video and plans, (2) independent research, which is extended by the availability of internet search opportunities, and (3) construction, which is made possible by ICT-based tools.

In concluding this report, it is important to stress again the relationship between the two sections of our findings: the close observation of learning practices through lesson log analysis, and the wider contextual perspective on learning practices conveyed in the emerging themes. The themes that emerged as particularly significant have many correspondences with the key findings from the 85 lessons. We have emphasised aspects of ICT in schools: vision and leadership, the goals and structures of out-of-school learning, the importance and multifaceted nature of staff development, and the redefinition of learning spaces.

Learning enjoys impact in four particular senses that we regard as emergent or overarching:

1. **Differentiation** – fresh opportunities occur for responding to individual differences and needs.

2. **Inspiration** – experience of the technology in use can be a source of ideas for creative extension and elaboration of activity.
3. **Coherence** – the nature of this technology allows the threat of fragmentary learning experience to be overcome as otherwise separate activities are coordinated in novel ways. Separate episodes of learning are integrated across time and space and as communities of common interest are created by the contact between groups and individuals that is made possible by an ICT infrastructure.
4. **Engagement** – students value the learning experience through the new forms of variety that access to ICT furnishes. Moreover, there is evidence to suggest that certain affordances of new media enhance classroom participation, feedback provision and pace of learning, offering multimedia representations and linking to future professions.

None of the schools involved in this research project saw their journey towards e-maturity as complete. In every school there were areas of relative success and failure. Every headteacher saw embedding ICT in learning as work in progress, particularly in relation to home-school links and the involvement of parents. Many of the innovating and creative teachers whose lessons we reported were frustrated over problems with slow network response times, lack of easy remote access to school software and servers, inability to use web resources due to filtering constraints, and the lack of regular access to a well-resourced multimedia classroom. But one thing was clear- these ambitions and frustrations were not those of teachers who were going to turn away from technology. They were already using multiple sources of hardware and three or four pieces of software in many of their lessons, and they were on a professional trajectory that understood that education is changing irreversibly, and that ICT was going to dominate and inform the learning practices that would define their role as teachers in the future.

Bibliography

Ainsworth, S E (2008), 'How do animations influence learning?' in Robinson, D and Schraw, G (eds), *Current Perspectives on Cognition, Learning, and Instruction: Recent Innovations in Educational Technology that Facilitate Student Learning*: Information Age Publishing, pp 37-67.

Becta (2009), *Harnessing Technology Funding 2010-2011: Guidance for Schools*. Becta.

<http://publications.becta.org.uk/display.cfm?resID=41336>.

Comber, C, Lawson T et al (2003), *ImpaCT2 Strand 3: Learning at Home and School: Case Studies*. Becta

Davis N, Taylor C, Tearle P and Wright B (1992), 'Staff Development Strategies for Information Technology in Teacher Education, in Somekh, B (ed), *Developing Information Technology in Teacher Education* (DITTE), Number 6: National Council for Educational Technology (NCET).

Davis, N (1997), 'Strategies for staff and institutional development for IT in education: an integrated approach', in Somekh, B and Davis, N (eds.) *Using Information Technology effectively in Teaching and Learning: Studies in Pre-Service and In-Service Teacher Education*: Routledge

Harrison, C, Lunzer, E A, Tymms, P, Fitz-Gibbon, C T and Restorick, J (2004), 'The Use of ICT and its Relationship with Performance in Examinations: a Comparison of the ImpaCT2 Project's Research Findings Using Pupil-level, School-level and Multilevel Modelling Data', *Journal of Computer Assisted Learning* 20 (5), 319-337.

Johnson, D C, Cox, M J, Watson, D M (1994), 'Evaluating the Impact of IT on Pupils' Achievements', *Journal of Computer Assisted Learning*, 10,138-156.
www3.interscience.wiley.com/journal/119836971/abstract?CRETRY=1&SRETRY=0

NCET (1994), *IT Works: Stimulate To Educate*, NCET, 1994.

Pittard, V, Bannister, P and Dunn, P (2003), *The big piCTure: The Impact of ICT on Attainment, Motivation, & Learning*, DfES.

<http://publications.teachernet.gov.uk/default.aspx?PageFunction=productdetails&PageMode=publications&ProductId=DfES+0796+2003&>

Somekh, B (1998), 'Supporting Information and Communication Technology Innovations in Higher Education', *Journal of Information Technology for Teacher Education*, 7(1), 11-31.

Underwood, J and Dillon, G (2005), 'Capturing Complexity Through Maturity Modelling', in Somekh, B and Lewin C (eds), *Research Methods in the Social Sciences*: Sage, pp. 260-264.

Somekh, B, Underwood, J et al (2006) *Evaluation of the ICT Test Bed Project*. UK: Nottingham Trent University
www.evaluation.icctestbed.org.uk/about

Underwood, J, Banyard, P, Baguley, T, Dillon, G, Farrington Flint, L, Hayes, M, Le Geyt, G, Murphy, J, and Selwood, I (2010), *Understanding the Impact of Technology: Learner and School Level Factors*, Becta.

Underwood, J, Banyard, P, Betts, L, Farrington-Flint, L, Kerlin, L, Stiller, J and Yeomans, S (2009), *An Exploration of the ways Technology can Support Approaches to Narrowing the Gap for Underachieving and Low-achieving Learners in Secondary Schools*, Becta.

Appendix 1: Technical note

Method

As detailed in section 1 of the main report, the overarching aim of the project is to understand the complex relations that surround different ICT-based practices in a given school context with a view to redefining traditional notions of impact of ICT on learning. For this purpose, an in-depth approach was adopted across a small number of secondary schools. The focus of the study was ICT-based learning, the school and the individuals within it. In order to elicit factors that revealed different types of impact of ICT on practice, the study sought to combine infrastructural, historical and individual perspectives on ICT. The sections below present the design of a multiple perspective study including the selection of participants: the school sites and key members within them.

Study design

In seeking to overcome the limitations of single focus outcome-oriented studies, the current study adopted multiple perspectives in order to understand the impact of ICT on a particular school setting. An iterative design that allowed different stages in developing understanding of the site was also essential. This approach helped to overcome potential issues of biases on the perspectives and information obtained on the school. There were two main foci of our data capture. Firstly, the school settings, as viewed from a range of perspectives. Secondly, the teachers' practice and views on the types of learning mediated by ICT. Actual instances of teaching practices, together with accounts from teachers, were then interpreted in relation to the history, infrastructure and communication dynamic of the setting. These multiple foci within each case constitute a source of validation of the perspectives. They also generate valid explanations on practices and types of learning in particular contexts.

In order to bring together these multiple perspectives, the data collection was designed to take place over three temporal phases. During each phase, we gathered information of sufficient breadth and depth to build a final understanding of the ecology of learning within each school. During the first phase, we focused on the school as a whole. During the ensuing two phases, we probed further to offer deeper insights into the range of practices that occur in a setting and the contextual circumstances that maintain them. The three phases are outlined below.

Phase 1 Deep school audit

The first visit to the schools elicited information on the following contextual factors:

- history of the school
- the views and rationale that had informed their particular approach and development
- infrastructure, network
- staff training and development
- communication with parents
- curricular philosophy and common practices (general and ICT-specific).

In order to draw an understanding on the above areas, the visits involved interviewing a broad range of school staff members:

- one senior management team member
- head of ICT
- network manager
- two ICT innovation leaders
- four classroom teachers.

The interviews were semi-structured, following the list of topics above with all staff members. This offered both validation of perspectives and contextual information on the school.

Phase 2 Teacher logs of ICT-based lessons for learning

This phase was designed to elicit concrete examples of classroom teaching that involved ICT. The same teachers interviewed in Phase 1 were asked to report on examples of their teaching where ICT was used. This generated a set of concrete learning activities that were interpreted in the light of information on the institutional context obtained in Phase 1.

All classroom teachers in each school (approximately 4 teachers per school) were asked to complete logs with specific requests to provide data on:

- lesson goals
- location in school (with a school map)
- classroom layout
- lesson activity
- lesson outcomes: self-reported
- use made of ICT.

Logs could include video, image, and sound file data. Teachers were asked to fill in and return a PowerPoint diary template delivered to them via email. Towards latter phases of the project we were able to offer a more user-friendly web-based version of the template. This requested exactly the same information as the PowerPoint log reports, but was submitted directly over the web. The web-based tool also incorporated a voice recording facility to make it easy for teachers to record commentary. Below there are some screenshots of the overview of the web-based log interface (Figure 7) and an example of a classroom layout (Figure 8).

Figure 7 Introductory page to the web-based version of the teacher log

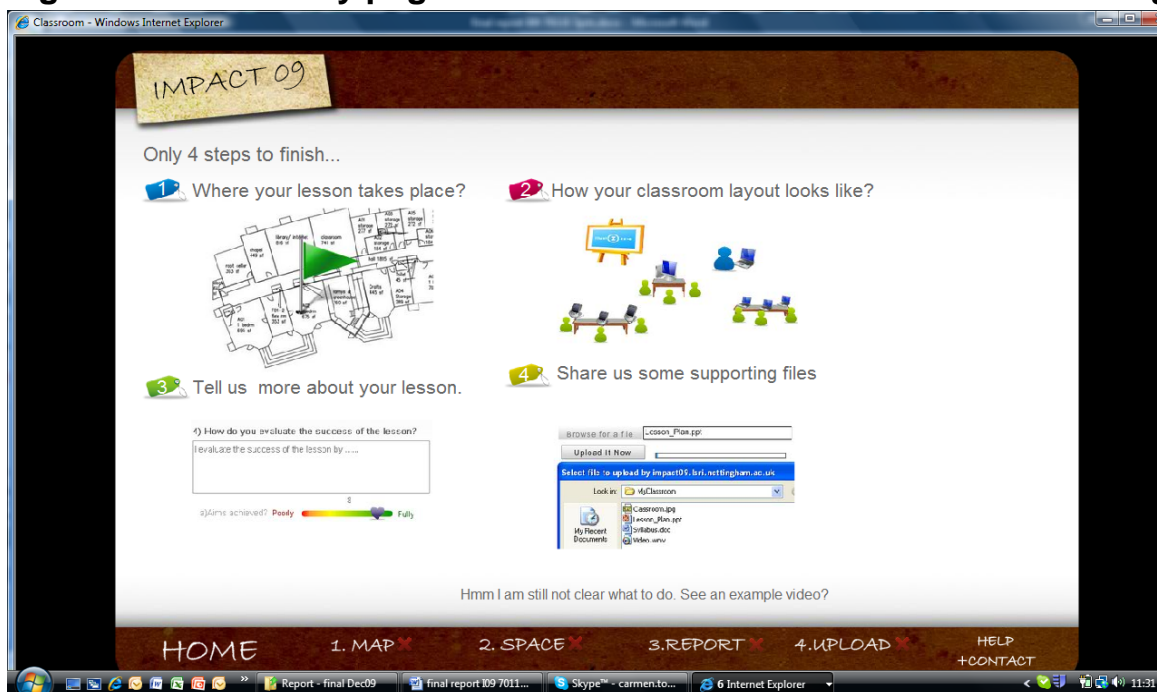


Figure 8 Example of classroom layout (in response to question 2, space)



Phase 3 Follow-up teacher interviews and student focus groups

The main objective of this phase was to conduct follow-up interviews grounded in the examples submitted by teachers in their logs. By inviting teachers to reflect on their own teaching, we elicited a more thorough articulation of factors that might mediate their practice. This provided data on teachers' beliefs, aspects of infrastructure, institutional pressure and dynamics of dissemination, among other factors.

Teachers were presented with excerpts of their own teaching and, where necessary or relevant, examples of those who were teaching in other settings. Selected quotations from Phase 1 interviews, or teacher log segments (found to be relevant or needing clarification), served as prompts to elicit further reflection. These reflections provided deeper insights into the teaching and learning goals and pedagogies of teachers. It also offered a richer explanatory basis for understanding the impact of ICT in these schools. All interviews took one hour and were recorded digitally.

This final visit to the sites also incorporated student focus groups. These augmented the staff perspectives on learning and ICT use in the school. Two focus groups took place at each of the sites. One focus group took place with Year 10 students and another with Year 8/Year 7 volunteer groups. The groups comprised six to ten students. The focus groups took up a maximum of one hour. The three main areas of the conversation with students were:

- applications that students use or have used generally in the school
- their perception of the usefulness of those applications
- Students' views on which applications they would like to have in the school.

The sample: project sites and participants

Nine different secondary schools across the UK were selected on the grounds of having demonstrated e-maturity, together with high contextual value-added (CVA) scores. The school headteacher and the ICT coordinator recruited the senior management and teaching staff members. The ICT coordinators arranged the recruitment of volunteer students to take part in interviews and focus groups.

Analysis of teacher logs: learning practices

Analysis of the 85 teacher logs provides rich insights into the mediational aspects of the technology in specific teaching episodes. The logs offer data on teachers' perceived success of the lesson in different respects (curricular, behavioural, ICT-related). Teachers' ratings on each teaching episode are summarised in Chapter 3, along with graphs reflecting the relation between the overall number of lessons and the collective rating levels.

Analysis of teachers' representations of their classroom spaces together with their comments suggests key factors involving the insertion of ICT in classrooms. This analysis includes patterns of classroom layouts reported in the lesson logs and commentary from teachers relating to space in interviews from Phase 3.

Analysis of the teachers' logs focuses on the learning practices mediated by the different ICT applications. We have used a taxonomy to systematise this analysis. This taxonomy deliberately seeks to represent an ecological approach and is therefore unlike cognitive level taxonomies (for instance, Bloom's system). The objective of the taxonomy is to provide tools to identify the different forms of concrete learning *interaction* that can be arranged. Insofar as the taxonomy serves to 'theorise' learning, it does so through a set of distinctions that are grounded in familiar classroom interactions. The cognitive significance of these interactions can then be derived – an exercise which is outlined in Appendix II but not pursued here. More importantly, the taxonomy allows identification of how technology is being adopted in terms of the learning interactions into which it is being positioned by teachers.

Table 2 below proposes 19 forms of interaction that a student might take part in, where the objects of interaction are material things, symbols, or other people. Full descriptions of the categories can be found in Appendix I. Such 'interactions-for-learning' offer a variety of ways in which a student's knowledge may be elaborated. It is proposed that a taxonomy of this sort suits a context where interest centres on the impact of technology on learning. This is because of the mediational role of technologies - the coming between ourselves and the world (that is, things, symbols or people). Thus in situations where technology is being used, we can ask: "Which learning practices is it mediating?" We might then ask, "How efficiently, economically or convivially is it doing so?" We might also ask whether its involvement with that interaction enriches the experience. A related question would be, "Does the

availability of technologies shift the *profile* of learning interactions that are chosen or cultivated in some place of learning?"

The leftmost column in the table is an attempt to organise the 19 forms of interaction. 'Instrumental' items are interactions that are not necessarily involving other people in direct relationship. They involve learners interacting with symbolic or concrete material in a manner that supports the elaboration of knowledge. 'Dialogic' interactions are those that are one-on-one interpersonal exchanges. They involve the learner in an encounter with another individual such that the form taken by that exchange extends thinking and understanding. 'Communal' interaction involves people in a more diffuse or distributed sense of interpersonal exchange. It may be less intense or intimate and it may be more loosely distributed over time and place. 'Scenarioed' learning interactions are more formally constructed configurations of some setting for learning. They allow the interaction to take particular shape and direction that is cognitively useful.

Table 2 Learning practices

| | Learning Practice | Learners mediated interaction |
|--------------|--------------------------|--|
| Instrumental | Searching | A directed or improvised exploration of subject materials |
| | Annotation | Record elaborating commentary on subject materials |
| | Rehearsal | Recall and exercise relevant domain elements and processes |
| | Representing | Design and manipulate symbolic formats of subject matter |
| | Ludic | Un-directedly explore materials to generate positive affect |
| | Construction | Build artefacts, knowledge, or representations relevant to some subject domain |
| | Reflection | Consciously systematise one's own evolving learning |
| Dialogic | Exposition | Implicit dialogue with authorial voice |
| | Tutorial | Engage in dialogue with more knowledgeable other |
| | Assessing | React to feedback from an authoritative other |
| Communal | Performative | Publically present a domain-relevant construction |
| | Networked | Distributed and intermittent exchange of subject-related understandings |
| | Participative | Integrate with a community of learners who share knowledge-building ambitions |
| | Collaborative | Exchange to deliberately create shared knowledge |
| Scenarios | Cross-Contextual | Integrate and manage activities over multiple contexts |
| | Case-based | Engage with the components of a subject-relevant case |
| | Simulation | Manipulate a functional reproduction of subject-relevant system |
| | Problem-focused | Solve a specific problem defined as subject relevant |
| | Scripted inquiry | Execute a scaffold of investigation or articulation |

Analysis of interviews: thematic analysis

The thematic analysis considers learning practices based on teachers', senior managers' and students' accounts of the impact of ICT on learning. Teacher accounts and opinions serve as primary data. These have been carefully considered and linked to the teacher lesson logs, as well as to accounts of how the infrastructure of ICT in the school has supported the use of technology, how staff development has supported teachers, and how curriculum change and changes in assessment practices have supported new uses of technology in learning.

The thematic analysis covers contextual aspects such as management and staff development (to facilitate change and ICT take-up in organisations). Key themes have been drawn based on their significance in several of the school settings and across all teachers and students. These themes are elaborated in Chapter 3.

Appendix III shows six examples of case notes on participating teachers. The case notes provide an overview of learning practices, contextual enablers and constraints, other contextual factors and a summary of the perceived affordances of the technologies as used in specific instances.

Appendix II: Learning practices

The learning practices used to consider ICT mediation in the 85 lessons are defined in more detail here with example technologies that might be involved in such mediation.

Searching: Direct or improvise an exploration of subject materials

This is an interaction with knowledge structures whereby the learner searches for items relevant to their interest or curiosity. A search may be improvised and opportunistic (more traditional sense of 'browsing') or it may be guided by principled rules (more 'strategic' approach). Education should furnish an interest in exploration through unguided browsing as well as the skills necessary to be more strategic.

ICT in the form of internet access furnishes a rich context in which to exercise browsing, however it also demands skills (while also offering tools).

Examples: search term technologies; CiteULike (an online library) and other data mining and collecting tools.

Annotation: Record an elaborating commentary on subject materials

This is an interaction with existing knowledge material (particularly text), such that the tools allow the learner to construct a personal elaboration of that material. This might take the form of commentary closely attached to the original ('marginal notes') or it might be a form of personal précis or reflection ('summarising' and so on). Knowledge is thereby elaborated or personalised. This practice suits situations where a body of well-formed material is available for study. Its cognitive benefit arises from the effort of actively re-casting material and selectively linking it with existing knowledge. Clearly annotation is something that can be done more or less skilfully and demands practice and support.

ICT offers tools that can structure (activities such as note taking) as well as offer an infrastructure for composition. It can also provide storage tools for writing and filing the products of 'active study' pursued in this manner.

Examples: Web page annotation tools; word processing functions that are adapted to structured note taking; the review features of word processors and personal computer filing systems that are used to organise personal notes.

Rehearsal: Recall and exercise relevant domain elements and processes

This is an interaction in which the learner is able to exercise key skills and knowledge relevant to the domain. For instance, a learner might carry out arithmetical operations or practice language vocabulary. Such activity supports the learner in building a robust database of knowledge relevant to some domain which can be recalled for processing in required contexts (such as solving arithmetic-based problems or conversations in a foreign language).

ICT can be a presentational tool for such problems that allow exercise of core skills and recovering of core facts.

Examples: drill and practice software and language pronunciation demonstrations.

Representing: Design and manipulate symbolic formats of subject matter

This is an interaction whereby some experience in the world (an artefact, event or process) is reproduced by invoking and manipulating some system of representing that experience. Such activity allows the learner to make their understanding overt and explicit – as well as creating an exploratory space within which that understanding can be manipulated.

ICT provides representational tools that can be readily manipulated, stored and shared.

Examples: the concept map and other screen-based systems for constructing representations; Autograph (an algebra and geometry exploration package); painting packages.

Ludic: Un-directedly explore materials to generate positive affect

This is an interaction allowing playful, relatively undirected engagement with domain-relevant material, such that exploratory manipulation of that material is rewarded with positive affect. Such activity allows the learner to experiment with knowledge in a relatively unstructured manner, thereby exploring properties and affordances of the domain.

ICT can provide microworlds in which such exploration is readily offered along with the possibility of playful creations

Examples: Various games-for-learning.

Construction: Build artefacts, knowledge, or representations relevant to some subject domain

This is an interaction with material that supports the building of artefacts, knowledge or representations. Such activity allows the learner to exercise principles of some knowledge domain through the demands of constructing an end product calling upon that knowledge.

ICT may provide tools that allow creative development, such as the construction of video, montage, narrative representations, and so forth.

Examples: Animoto, Movie Maker, PowerPoint

Reflection: Consciously systematise one's own evolving learning

This is an elaborating interaction with a record of one's own learning activities. This might take the form of a diary with evaluative personal commentary. Personal knowledge building is thereby subjected to critical scrutiny and adjustment. This practice cultivates the metacognitive skills necessary to refine and structure personal knowledge building activities.

ICT offers tools that assemble the achievements of learning and allow some form of (shareable) reflective commentary to be superimposed upon them ('annotation', where the object of annotation is a personal record).

Examples: the e-portfolio and the blog

Exposition: Implicit dialogue with authorial voice

This is a private interaction with an author or speaker who is using some tool to present a narrative account of knowledge to a learner. This might take the form of a lecture, or a textbook or a multimedia presentation. Knowledge is thereby 'exposed'. This practice is well suited to situations where expertise can be transmitted in structured narrative form. The cognitive benefit arises according to the depth of private interrogation and meaning-making encouraged in the listener/reader/viewer.

ICT offers tools that package and make accessible such structured accounts. However, the success of this form of learning practice depends on the depth of the private interaction elicited from the (otherwise passive) learner. Thus technology may support such depth of interaction by making material vivid or representationally rich.

Examples: Podcasts of lectures; YouTube explanatory videos; EBooks; Wikipedia and other reference materials online.

Tutorial: Engage in dialogue with more knowledgeable other

This is an interaction in which the learner takes part in a dialogue with a more knowledgeable other. The quality of the interaction depends on the manner in which the dialogue is orchestrated towards building and interrogating knowledge. This practice externalises the process of scrutiny and questioning, as well as furnishing a context for more explicitly interrogated exposition (see above, under 'exposition').

ICT can support dialogues in text or voice, particularly where partners are not co-present. Technology may also blend that conversation with forms of visual representation on associated whiteboards, and so on. It may simulate the human partner in such dialogues.

Examples: Intelligent tutoring systems; chat-based discussion forums; Skype exchanges.

Assessing: React to feedback from an authoritative other

This is an interaction that optimises opportunities for one person to feedback on the knowledge-building product of a learner. This practice equips the learner to recognise and respond to a critical voice applied to their own efforts.

ICT provides tools to traffic in assessment interactions – potentially making them more prompt, representationally rich and interactive.

Examples: learning platform structures that support online submission and commentary on student work; tools for embedding voice or images as feedback to submitted files.

Performative: Publicly present a domain-relevant construction

This is an interaction with an (implicit or explicit) audience. Personal knowledge is shaped in such a way that it is actively disseminated – made the object of attention (and critique perhaps) by others. This practice encourages an awareness of personal knowledge in terms of how it may be seen by and be influenced by others. This requires engaging with those alternative perspectives and considering how knowledge allows itself to be shaped to come into relationship with them.

ICT offers tools for dissemination and audience reaction.

Examples: the blog; the expository video on YouTube; the wiki.

Networked: Distributed and intermittent exchange of subject-related understandings

This is an interaction in which learners make intermittent contact with others for data co-ordination or interrogation, although it is usually separated by time and space. Knowledge patterns are thereby established for navigation and querying. This practice cultivates a model of knowledge. It distributes and facilitates patterns of engagement that support creative questioning of such structures.

ICT provides an infrastructure for assembling and managing networked knowledge and for navigating to nodes where informants may be interrogated.

Examples: topic-centred mail lists; discussion forums, or ning sites; personal databases of contacts for one-to-one or one-to-many querying; Delicious and other shared bookmarking tools.

Participative: Integrate with a community of learners who share knowledge-building ambitions

This is a structure of interaction that creates circumstances for fostering integration among a group of individuals who have an evolving history of shared understanding and practice. The cognitive gain of this concerns the confidence and identity of the individual, a 'member' of a learning community/discipline. It also creates a knowledge structure within which the individual learner can seek other learner relations.

ICT can provide infrastructures that establish and shape the felt sense of communication and community and which create tools for individuals to become participants, rather than mere communicants.

Examples: The Knowledge Forum and other networked designs for shaping and making visible corporate identity and products.

Collaborative: Exchange to deliberately create shared knowledge

This is an interaction in which two or more individuals deliberately strive to create shared knowledge. This practice allows individual to acquire interest, skills and confidence in knowledge construction activities that take advantage of the expertise of others and which gives an affective motive for that knowledge building

ICT can provide a context at which collaborators may assemble and share representations.

Examples: classroom arrangements within which small groups may work together at a shared site of representation and recording. Internet communications may support collaborative knowledge building at a distance and synchronously.

Cross-contextual: Integrate and manage activities over multiple contexts

This is an interaction in which learners integrate meaning across different contexts of representation or activity. The cognitive benefits arise from positioning the same ideas in more than one setting or by simply extending the range of knowledge searching and integration.

ICT equips the learner with tools to capture, store, compare and integrate material from multiple contexts.

Examples: mobile recording and communication tools, including handheld devices, cameras, phones and GPS enabled devices.

Case based: Engage with the components of a subject-relevant case

This is an interaction in which the structure and working of a disciplinary 'case' is pursued. This allows the learner to understand knowledge in the context of an authentic example, providing an integrated and meaningful context for disciplinary content.

ICT can provide a structuring and exploratory context for the presentation of case material. It offers a condensed form of representation with interactive possibilities – allowing the case to be viewed and explored in an economical manner.

Examples: semantic technologies that support investigation of cases and self-contained case realisations in virtual format.

Simulation: Manipulate a functional reproduction of subject-relevant system

This is an interaction allowing control over some model system representing domain-relevant processes. The learner is allowed to manipulate qualitative or quantitative parameters in order to investigate functioning or construct desired outcomes. The activity benefits learners by allowing the functional properties of a system to be experienced directly, such as to support experiment.

ICT can provide self-contained environments in which such systems are modelled and which allow active manipulation.

Examples: Educational games such as, Civilisation; Astroversity; Racing Academy; Savannah

Problem-focused: Solve a specific problem defined as subject relevant

This is an interaction in which the learner is challenged and supported to solve domain-relevant problems. The learner thereby encounters domain knowledge in the context of authentic problems and is motivated to exercise that knowledge.

ICT can be a presentation resource for encountering problems designed by others. That presentation may include tools for the exploration of the problems made available.

Examples: Presentational contexts for defining a problem and offering solution and dissemination tools.

Scripted Inquiry: Execute a scaffold of investigation or articulation

This is an interaction in which the route through an inquiry space is defined and guided by a script of steps. The learner, thereby, is scaffolded in the relevant problem solving strategy.

ICT can offer tools that guide the learner through a process of enquiry by specifying a succession of moves relevant to approaching an agreed goal. These scripts may scaffold a conversation in collaborative contexts or drive a pathway for individuals.

Examples: LMS and other learning design scaffolds.

Appendix III: Cases on learning with ICT in six schools

This appendix presents six case studies. Each one draws from information reported in teacher logs together with reflections from interviews in Phases 1 and 3. The case notes present teachers' descriptions and are representative of the lessons relevant to the focus of this report. Each lesson is summarised and includes the learning practices inferred from the various records. These cases offer a short commentary on the teaching and learning in terms of the following themes: space, history and trajectory, affect and community. The final section highlights teachers' evaluative perspectives on affordances, enablers and constraints, as well as other information relevant to the context of teaching and learning.

These teacher case notes are derived from data described within Sections 3 and 4 of the main report on key findings.

English and ICT (School 1, Teacher 1)

Aims and ambitions

The lesson log and associated interview describe an overall aim of increasing awareness of the effects of presentational devices as they might be tailored to specific audiences. This fits with introductory GCSE and includes the introduction of presentational devices such as posters, web pages, TV adverts and movie editing software. The ultimate goal is for students to use this knowledge to create a campaign for launching a mobile phone aimed at teenagers. The sessions are delivered to Year 9 students at the end of the school year and serve as an introduction to GCSE English.

Mediation

Technologies used include learning platforms, the internet, PowerPoint and interactive whiteboard (IWB).

Learning practices mediated by these technologies include:

- exposition: the teacher explains how to carry out a task using IWB.
- searching: students search on the internet for relevant illustrative material.

- construction: students choose their own content and approach to the campaign and design. Technology use allows students to excel in new ways and increases collaboration and peer feedback.

Space

There is an emphasis on flexible use of space: the layout follows a U-shaped design with extra tables inside that can be moved in order to make small groups. The teacher emphasises that such small changes are significant enough for the students to feel they are in groups, as opposed to being in a line. She indicates that this is a good layout but wishes she had a little extra room to allow movement around the edges of the classroom.

Trajectory

There is an emphasis on relating work to year-end exams by increasing reflection using podcasts and blogging to record ideas and evaluate students' work. Emphasis on the program Kartouche Movie Maker for storyboarding also allows students to manipulate the size, space and rotation of images.

Affect

The technology is particularly empowering for students and allows them to demonstrate their skills to the teacher and other students.

Community

The teacher is keen to establish links with the home and sees potential in uploading student work onto the learning platform. The learning platform is currently being reworked alongside the student website. This teacher would like to store a gallery of each student's work here in order to show parents the development of their children's work and also the final pieces, for example, a piece of creative writing or a storyboard.

Evaluative perspective

Affordances

- ICT encourages autonomy of learning by allowing students to make choices about the task.
- Technology allows for immediate teacher feedback of student work and coursework.

- Technology allows students to demonstrate both peer teaching and collaboration.
- Technology provides motivation and allows autonomy over choice (paper-based work versus technology-based work).

A key focus of the lesson is on autonomy of learning, whereby students choose the medium in which to produce their campaign. The use of technology is employed to empower students to develop new skills and utilise their strengths in producing their campaign. Further, the role of ICT is regarded as redressing the balance of teaching and facilitating by engaging the students in peer teaching and collaborative work.

This program aids students' progress and allows for lower achievers to exceed expectations. There was also a desire for students to collaborate more and embed skills in this way.

Science and ICT (School 2, Teacher 5)

Aims and ambitions

This lesson log relates to a GCSE physics module with high engagement and the use of interactive visual technology to make distance-time graphs based on movement. The focus is on a highly interactive session rather than theoretical content. The use of specialist equipment (data logger and motion sensor) allows autonomous learning using real-time examples and fosters collaboration among groups. Examples are displayed on-screen via projector, thereby allowing individual exploration of answers alongside group-based discussion and reflection.

Mediation

Technologies used include data logger, motion sensors, graph-making software, teacher laptop, projector and IWB.

Learning practices mediated by these technologies include:

- problem-focused: teacher uses technology for real-time examples of science. Technology is used to allow task manipulation to increase learning and understanding and to help students refine skills in addressing real-world topics.

- **assessing:** assessment for learning is prominent in this case study, which uses Assessment and Qualifications Alliance (AQA) information to compare progress and performance with others in the same curriculum or exam board.

Space

Flexible space is fundamental to learning. A large space is required for practical demonstrations and examples. Desks can be moved for more practical tasks or set in rows for more traditional activities or lessons (for example, for GCSE revision). Learning space is fundamental to managing behaviour and monitoring students' engagement level on tasks.

Trajectory

The teacher notes a strong shift towards interactive forms of technology and specialist equipment, as well as towards more group interaction and real-time results reporting from practical experiments. Possible future innovations to strengthen learning might include podcasts, RSS feeds, and a new learning platform. Other needs include: moving towards greater autonomy over learning (more online assessment packages); providing instant feedback; and promoting and sustaining independent, autonomous students.

Affect

The technology makes learning feel authentic. Changes in classroom layout allow for different behaviours and levels of engagement. Self-assessment is crucial for students to monitor their own improvements and meet exam board guidelines as preparation for examinations. Finally, group-based activities allow for peer learning and peer reflection on progress.

Community

There is an emphasis on strong links with the academic community in terms of comparing marks and progress with data on the AQA exam boards' websites. The teacher places less emphasis on sharing practice outside curriculum areas and on developing home-school links. The teacher also notes that a new learning platform will allow greater reflection on learning outside classroom, but the best actual tools to implement this are to be determined.

Evaluative perspective

Affordances

- Technology affords access to all students and reduces alienation of less able students. A strong shift occurred towards skill-based learning rather than primarily content-based learning.

- Flexibility in classroom layout is fundamental for engagement and behaviour modification.

Enablers

- Self-assessment is encouraged, but greater emphasis on online assessment packages may strengthen and support this initiative.
- A shift towards specialist equipment enables greater autonomy and group work and allows for using experiments in real-time rather than relying on paper-based alternatives.

Maths and ICT (School 3, Teacher 1)

Aims and ambitions

The teacher demonstrates how to construct spreadsheets, solve quadratic equations and construct linear graphs. The teacher uses RM Tutor in the PC Lab or DeskCam in the main teaching class to demonstrate mathematical concepts or show how to solve problems.

Mediation

Technologies used include RM Tutor, DeskCam, PCs, MyMaths and ActiveStudio.

Learning practices mediated by these technologies include:

- exposition: lesson focuses on how to construct an Excel spreadsheet and how to solve quadratic equations (RM Tutor, ActiveStudio, DeskCam, Maths Watch).
- rehearsal: students work individually to their own level on MyMaths.
- construction: students construct their own Excel spreadsheets, equations and graphs.

Space

In a class without personal PCs, the constraints of the room are the size as well as the need to have students facing the front of the room to look at the board.

In the computer room, having RM tutor and having students looking in different directions is not a problem because they can see the demonstrations on their screens.

The ideal classroom would have multiple screens displaying different bits of information on each.

History

This teacher is experienced and very positive towards technology and its integration into maths teaching and learning. He has a strong personal background in computers and programming and a positive attitude towards their integration.

Trajectory

Transformation of the school began nine years ago. It started using a projector and PowerPoint to replace overhead projectors (OHPs). Arrival of a new Head Teacher changed things in the school dramatically. At first, software was purchased that was not at the right level. More interaction has been achieved in the last 10 years, and teachers have gradually found ways to enhance student participation. Now they have the right software, MyMaths, which enables differentiation in a class and allows students to see their progress, for example, as they try to get Cs to Bs. This software also is used for homework. The school's and the teacher's objective is to provide more individualised learning. The teacher is now looking at making small video clips of topics to send to students' mobile phones.

“The stuff in the computer rooms I'll probably leave the same, although I'd try bits and pieces just to keep changing; otherwise, we'll stand still [and] go backwards. We'll keep looking at other software because My Maths isn't going to last us forever. There'll be something that comes out that's better. As with the lesson, as it stands, if I had to do it tomorrow, I wouldn't change it.”

Affect

Overall, the teacher and students are very satisfied. The teacher rates highly the technology use and achievement of curricular goals.

Community

Stronger links with the home are enabled via online maths websites and the school's learning platform.

Evaluative perspective

Affordances

- MyMaths affords differentiation, with each student working to their level and at their own pace.
- ICT motivates students to make progress at a faster rate by enabling them to instantly see their feedback and to monitor their progress in class. The teacher displays students' progress on the board when they work on MyMaths:

"I think it's the instant feedback. When you're in a classroom, even if you can get round and check the kids' [work] and you do question and answering, you're not catching everyone. They know you're not catching everyone, so there's a bit of feeling that 'there's a good chance I can get away with this, I needn't work as hard. I can do a bit and Sir won't catch me'. Whereas, when they're on [programs] like My Maths, you've got that assessment grid that I put on the screen shot. That changes throughout the lesson, so I have that up on the main board and I just keep clicking 'refresh' and the kids think 'Oh, God.'"

- The technology allows the teacher to identify who has problems and intervene (through RM tutor):

"[I]t is the same as what I do on the whiteboard, but as they go through the lesson and put up their hand for help, I'm able to control each individual computer... So I can either control that child's individual computer, or if I think that's a problem the whole class [has], I put it up on the big screen [and say], 'Everyone look at this.' Or I put it onto everyone else's screens and say, 'I'll show you how to do the work.'"

- The technology enhances individual focus and attention. Having the demo done on each student screen is better than the display on the IWB. This way, the students also can work on their own constructions while having a demonstration on the screen:

"I just put it on all the individual kids' computers and they all sit there in silence looking at their own screen," the teacher notes. "[T]here's nothing to distract them from their computer... and I've got their full attention [Interview Phase 1]."

- The demo is accessible to students. Doing a demo with DeskCam uses tools similar to those the students have (the same paper they use). In comparison to other tools, the DeskCam offers the advantage of a live demo of a construction:

“... just doing equations and stuff, [students are] a lot more focused seeing someone write it out. I think it slows me down a bit because if I've just got a PowerPoint I'm going through, I might go through it a bit quickly. But if I'm going through a question on a sheet of paper and they're watching me write on it... in my eyes, it's the same as doing it on the board and showing them. They follow it, and the timing seems better and they're thinking along with [me]. I didn't expect it to but it has helped for that as well.”

- ICT supports revision at home through the ability to save class work onto the learning platform and transfer it to PowerPoint (if done on ActiveStudio).
- ICT provides the opportunity for more alternatives, for example via MathsWatch video:

“I think [students enjoy] watching the videos of MathsWatch. I'll run the video through...and I can wander round the class, see how they're doing. I can go through it again, and they're hearing two different voices. I know it's the same thing that's being said, but it really does help, hearing it a second time from a different voice.”

Constraints

- Maths demands a lot of exposition and teaching from the front.
- Poor-quality equipment creates problems.
- Blocked websites are a disruption.

Enablers

- Since the new headteacher came, the school has been equipped with IWBs and other kits. This has enabled changes in the teaching and learning.
- The school has a strong culture and pushes for the cohesive use of the learning platform by all teachers.

Music lessons using ICT (School 5, Teacher 2)

Aims and ambitions

This case focuses on an exercise in experimental music based on voice work. This project reflects the use of technology over five related lessons. Technology was recruited to solve a persistent problem in secondary music education: students' lack of experience with performance at primary level. Film was a sort of leveller.

Mediation

Technologies used include laptops, video recording tools, the learning platform and blogs.

Learning practices mediated by these technologies include:

- reflection: blogs and video recordings are used for self-evaluation.
- exposition: the learning platform is utilised to put up preparatory material for the lesson.
- assessing: feedback is delivered via the blog on the learning platform.
- performative: the learning platform plus film is used to broadcast recorded performance.
- representation: film forces new attention to the balance and structure of performance.

Space

Space in music is usually determined by instruments, but in this case netbooks gave students the freedom to take them (as the main recording and production device) to wherever they could find space.

History

The teacher has a long record of interest in innovating with ICT.

Trajectory

The teacher will take forward and do similar activities, but hopes for faster access and less overload.

Affect

The sessions were well rated by the teacher, and students enjoyed much of it, but there was frustration from slow response time. The teacher was disappointed by lack of audience take-up.

Community

This case emphasises sharing work between students, but also involving the parents as audience via the learning platform. Neither of these things worked well due to a lack of engagement with the learning platform across the school.

Evaluative perspective

Affordances

- The learning platform worked as a broadcast option infrastructure.
- There was a strong sense of the learning platform resourcing the lessons by making all material available before attendance.

Constraints

- The learning platform failed in that not enough students or others referred to it.
- Netbooks liberated the space issue but acted as a distraction. However, this was due to novelty, although the teacher observes that other less confident teachers would have been put off by this kind of experience.
- Seeing oneself performing on a film may not be a universally enjoyed experience.
- It takes a lot of time to do this. This teacher is exceptional in seeing this opportunity and taking the time to realise it.
- The school needs to do more to make time available for teachers to reach an appropriate level of speed and engagement.

Art and ICT (School 6, Teacher 2)

Aims and ambitions

This teacher reported on several lessons using ICT. She uses ICT to generate artwork after presenting Fauvism. As part of art lessons, she also introduces multiple-choice questionnaires via the learning platform and uses electronically submitted responses to feed back into the planning of the module.

Mediation

Technologies used include Photoplus, students' mobile cameras, the learning platform, students' laptops, online quizzes, PowerPoint presentations on Fauvism and a projector.

Learning practices mediated by these technologies include:

- construction: students edit photos.
- assessing: this was done by quizzes with true/false and multiple-choice options.
- ludic: quizzes are fun and do not feel like "learning".
- exposition: the teacher shows aspects of Fauvism in a PowerPoint presentation. The teacher shows the history, theory and lots of visuals from the front. She can zoom in and isolate some parts of the work.
- browsing: students do their own research individually on Fauvism. They are given some tips and guidance, but they do this independently.

Space

Tables are arranged in a square shape with a display in the middle of the room. The layout is not chosen for this lesson in particular, but it is too difficult to remove it and then replace it.

History

This teacher is experienced and she has gradually adapted to the ICT tools available. She is positive towards adopting ICT as long as it has a clear benefit to learning.

Trajectory

This teacher has found that ICT-generated artwork offers a way to start producing pieces that would have been impossible with the traditional options. The teacher does not see ICT-generated artwork as replacing hand drawing, but she welcomes the benefit of using this to provide alternatives for students and differentiation for those who are less good at hand drawing. These students can still explore composition and achieve a good outcome.

She is currently changing the schemes of work for other year groups, in which personal laptops for students are being introduced.

Affect

The teacher rates the lessons well. However, she highlights that persistent technical problems interfere with the pace and progress and generate some frustration for students who do not get the work done.

Community

General communication with parents takes place by email. Parents have full access to the learning platform and the homework database.

Evaluative perspective

Affordances

- ICT-based activity is faster, offers more engagement and motivation, and enhances ownership and success of the group as a whole (more students can achieve a successful outcome).
- Students can achieve in one session a quickly generated image that they can then work into a larger project. Before the ICT applications, they would not have been able to achieve this in one hour.
- The technology enables enhanced ownership of the activity. Students use their own cameras to take pictures that they can edit later in the class. This makes the process faster, since there is limited availability of the school's cameras. In the past, the pictures were given to the students, but now they are fully engaged in the entire process. This feeds into their art composition, since they can experiment with the picture angles and perspective.

- ICT-generated artwork provides an alternative. It does not substitute traditional hand drawing skills, but offers the opportunity to obtain an ICT-generated piece quickly. Students can then reflect on the different opportunities of ICT-generated drawing and hand drawing. It provides an opportunity for those who do not have very good hand drawing skills to produce a good art piece.
- Students can obtain better results by avoiding human error in drawing.
- Enhanced motivation results in students thinking about how to apply skills outside of the lesson.

Constraints

- Technical issues are persistent, which can cause frustration for students and the teacher.

Geography and ICT (School 7, Teacher 5)

Aims and ambitions

The lesson logs focus primarily on using PowerPoint for a variety of purposes, including activating prior knowledge, motivation, whole-class discussion of geographical features, and revision. This teacher also emphasises and draws contrasts with her other uses of technology. In the previous year, her base room was a computer suite, and there had been more emphasis on ICT to support self-regulated learning, improved standards and coursework volume, and creativity (for example, the production of student videos of volcanoes).

Mediation

Technologies used include the learning platform, PowerPoint, IWB and digital recorders.

Learning practices mediated by these technologies include:

- assessing: the teacher notes better edited coursework, more volume, and higher student motivation. Students are able to access resources to enhance learning and have more autonomy (“they feel they are in control”). Students scroll digital images (reflecting activation of prior knowledge and motivation).

- exposition: PowerPoint is used for exposition but is augmented by class discussion. The teacher also notes that the technology facilitates the development of criticality and a focus on greater visual detail.
- ludic: the teacher uses PowerPoint for quizzes (recapitulation, assessment and revision, but with fun and pace).
- searching: Google Earth helps students develop mapping conceptualisation, but with the added motivation of seeing known locations represented.
- performative: students plan and teacher records digital videos on volcanoes; students subsequently critique videos with respect to representation of tectonic movement. Videos are used with following year group to pre-critique plans for similar videos.

Space

The teacher emphasises flexible use of space. In both the geography department computer suite and in her own room, this teacher makes use of a U-shaped space in order to permit a rapid switch from outward-facing individual or pair work to an inward-facing small group or whole class structure. Other teachers have changed their rooms to fit this pattern. The space in the middle is 'relaxed', and the outward-facing setup is better for more focused activity.

Trajectory

If the teacher can't be based permanently in a computer suite room (her preference), she would aim to have six networked computers in her room. This would permit computer-based extension work for individuals, plus whole-class computing with groups of four. Her use of PowerPoint has changed dramatically from text-based to image-based and from transmission to whole-class critique.

Affect

This section of the school happens to have older, slower computers than many areas, so slow log on and narrow bandwidth make the use of software such as Google Earth difficult and frustrating.

Community

The teacher is making increasing use of the extranet learning platform, and is rolling downwards from Year 10 towards younger groups. The geography welcome page has links to support material, but as yet her use of the e-portfolio system is limited.

Evaluative perspective

Enablers

- Learning platform use is becoming more widespread in the school.
- Motivation through technology is central to the teacher's philosophy.
- Perspective is perhaps shifting away from the content-centred resources to student-centred uses of technology.