ImpacT2 Project

Preliminary Study 2

Promoting Achievement: Pupils, teachers and contexts

Cathy Lewin, Peter Scrimshaw, Colin Harrison,

Bridget Somekh and Angela McFarlane

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Details of the research design and methodology are available on research web site at http://www.nottingham.ac.uk/education/research/impact2.html.

For further information contact colin.harrison@nottingham.ac.uk

ImpacT2 Preliminary Study 2

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Executive Summary

The Government's policy on ICT in schools makes two assumptions: first, that the introduction of networked ICT will improve attainment, and second, that we can identify the elements in the teaching and learning situation that affect whether and how networked ICT has this impact.

The ImpacT2 Preliminary Study 2 deals with the second assumption. Its specific purposes are to:

- develop a conceptual framework that identifies the contextual relationships between the main factors in the classroom, school and home environments that need to be taken into account in the project, including thresholds for effective ICT use (Section 2)
- identify through a selective literature review which contextual factors are of most importance (Section 3)
- explore ways of using established tests and explore ways of identifying or developing instruments to explore these relationships further (Section 4).

If we look first at the non-ICT classroom, the basic elements are the pupil, the teacher and the context within which they work together. The relationship between pupils, teachers and context can take many forms. At home the elements are essentially similar (child, parent, context) but the pattern of opportunities and limitations in the home is the mirror image of that in schools. This has implications for creating and developing home-school partnerships.

Introducing stand-alone ICT resources makes an impact upon this general framework, but what that impact is varies with the kinds of software and hardware being used. This presents teachers with an extremely complex innovation to introduce in which several different factors have to reach a satisfactory threshold level. Below these thresholds stand-alone ICT us likely to have no impact on learning.

While we cannot identify any quantitative levels for such thresholds, it is possible to make more explicit what factors appear to have thresholds, and in broad terms their relative importance as obstacles to success. The key factors appear to be:

- Learning time
- Mechanical reliability
- Capital costs for school
- Running costs for school
- Operational intelligibility
- Pedagogic intelligibility

- Perceived educational relevance

- Actual educational relevance

- Capacity to provoke unplanned learning by pupils and teachers

As the use of computers in schools has evolved, stand-alone computers have been increasingly supplemented or replaced by networked systems. These differ from stand-alone systems in that they are essentially time and/or space manipulators or a means of accessing very large amounts of resource. However, given the constraints that time, space and lack of resources place upon current classroom practices, this means that networked systems could prove to be very powerful agents for change in the classroom and home. They also change the relationship between the teacher and those taught (even reversing it), as well as changing what resources teacher and/or pupils have access to, and in what 'physical' and cultural contexts the learning and teaching take place.

The literature reviewed in preparing this paper covered both stand-alone and networked ICT use. It suggests the following as the main teacher, pupil and context factors that need to be taken into account:

Teacher:
- ICT training
- Access to ICT for personal development
- Technical/pedagogical support
- Confidence in classroom use of ICT
- Attitude to ICT in classroom
- Competence in classroom use of ICT
- Pedagogical practices

Pupil:
- Nature of use
- Access
- Pupil characteristics (what does this mean - the nature of being the pupil?)

Context:
- Amount of access
- Organisational structure of school and support.

From both the analysis and the literature review we propose a set of hypotheses, some centred upon the teacher and others upon the pupils and their access to various kinds of resource. These are as follows:

Teacher-centred hypotheses

Attainment will be affected by…
- differences in how teachers conceptualise networked technologies
- differences in teachers' training and support in the classroom use of networked technologies.

- differences in teachers' confidence in the use of networked technologies in classrooms, and attitudes to innovation generally
- differences in teachers' pedagogical practice, including the matching of learning objectives to the use of networked technologies, and the communication of this to pupils.

Pupil-centred hypotheses

Attainment will be affected by…
- differences in how pupils conceptualise networked technologies
- differences in pupils' access to networked technologies in their homes
- differences in pupils' access to networked technologies during classroom activities
- differences in pupils' access to additional curriculum resources through networked technologies
- differences in pupils' access to additional adult help through networked technologies
- differences in pupils' access to additional pupils through networked technologies.

We suggest that the impact of stand-alone ICT (and so by implication, possibly of networked technologies too) may be in part dependent upon the microstructure of the teaching and learning situations, rather than only upon the broader features of the situation. This in turn implies that what is needed for the Main Study is an approach that combines ways of catching the broader picture (and within that, any major effects that are present) and also ways of obtaining the more intricate detail. For this we will need a range of instruments to deal with the context factors. These will be:

- The representation Concept-Mapping Task.
- Teacher report
- Teacher diary
- Pupil report
- Pupil Diary
- NoF training status of teacher

In summary, we are dealing with the introduction of a rather diverse set of complex technologies. These are being introduced into classrooms with considerable differences in teacher, pupil and resource related features. The networked technologies being introduced will also be directed to a variety of educational purposes, some of which will initially be apparently clear to the teachers involved, whilst others will be more hazily conceived.

In essence the research strategy is to use a graduated set of research instruments, varying in their level of pre-specification of acceptable data and in the mix of quantitative and qualitative data that they will collect. In different ways, most of the context instruments, and some of the baseline and outcomes instruments allow the collection and analysis of data at a more or less fine-grained level. This will give us some room for methodological and analytical manoeuvre when (not if) the data from the teachers, parents and pupils begins to surprise us.

1. Introduction

The decision of the DfEE to evaluate the impact of Information and Communication Technologies (ICT) on children's achievement could not have been made at a more critical

time. In *Connecting the Learning Society* (DfEE, 1997), the government listed ambitious targets for schools, pupils and the ICT industry, which included the following:

- By 2002 serving teachers should generally feel confident, and be competent to teach, using ICT within the curriculum

- By 2002 all schools, colleges, universities and libraries and as many community centres as possible should be connected to the Grid, enabling perhaps 75% of teachers and 50% of pupils and pupils to use their own e-mail addresses by then

- By 2002 most school leavers should have a good understanding of ICT, based firmly on the standards prescribed in the curricula operating in the various parts of the UK, and there should be measures in place for assessing the level of school leavers' competence in ICT.

Behind these policies lie two key assumptions. The first is that networked ICT will indeed affect attainment. Study 1 has reviewed the key findings on this relationship. In Study 2 we turn to the second assumption: that we can identify the elements in the teaching and learning situation that affect if and how networked ICT has this impact.

The specific purposes of Study 2 are to:

- develop a conceptual framework that identifies the contextual relationships between the main factors in the classroom, school and home environments that need to be taken into account in the project, including thresholds for effective ICT use (Section 2)
- identify through a selective literature review which contextual factors are of most importance (Section 3)
- from this specify the key hypotheses to be investigated use (Section 4)
- explore ways of using established tests and instruments to explore these relationships further (Section 4)
- explore ways of developing new instruments to cover aspects of these relationships that cannot be reached with existing instruments use (Section 4).

2. Pupils, teachers and contexts: rethinking the assumptions

In this section we look first in outline at the conventional (i.e. pre-IT classroom) situation. We then consider what changes need to be made to this picture to take account of the introduction firstly of stand-alone ICT (i.e. non-networked computers), and then of networked technologies.

What are the elements to take into account in a conventional classroom situation?

The basic elements in a classroom situation are the pupil, the teacher and the context within which they work together.

In the case of the pupil, we need to consider how they conceptualise what they are learning, their confidence and the kinds of resources to which they have access. The extent of, and locations for, that access also matter.

For the teachers and parents there are issues of how they too conceptualise teaching and learning, what teaching skills they have, what educational philosophy they work within, what resources they have available and how well they understand the possibilities these resources offer. The extent of access to resources and the features of the various locations available are also significant. Teachers' confidence in their own capacities, and what additional advice and training they can draw upon are also important.

Viewed as a physical entity, the context comprises a setting in time and space, and within this various resources that the teacher and/or pupil can use. Where they are present, other pupils are a particularly important 'resource'. However, the context is also a cultural entity. What can be achieved in a given setting and with specific resources is partly a matter of their physical properties, but also of how they are understood and viewed by the participants.

How are these three elements typically combined?

The relationship between pupils, teachers and context can take many forms, and teachers and learners may employ a range of teaching and learning styles in varying combinations, using a variety of conventional resources. Each of these patterns can take place in both classrooms and homes. However, these two settings differ in a number of important respects. A speculative picture of these differences for classroom and home settings where only conventional resources are available is given in Table 1.

Education-related activities	**Home**	**Classroom**
Emphasis upon learning activities by: Pupil Teacher Parent	 Low Medium Variable	 Variable High Variable
Emphasis upon social activities by: Pupil Teacher Parent	 High High High	 High Low High
Level of control over activity by: Pupil Teacher Parent	 High-Low Low High-Low	 Low High Very low
Level of control over what is to be learned: Pupil Teacher Parent School Government	 High-Medium Low-Medium High-Low Low-Medium Low-Medium	 Very Low Medium Very Low Medium High
Opportunities for sustained activities	High	Low
Opportunities for: Whole class activities Group activities Individual tuition Independent learning	 Nil Low-medium High High	 High High Low High
Level of learning resource available	Low-Medium	High-Medium

Table 1: Speculative comparison of the kinds of education-related activities to be met in classroom and home settings where only conventional resources are available

These two settings vary not only in their physical design and the resources they offer, but also in their social significance to those involved. An important part of these differences in social significance is the balance between social and task focused emphasis seen as appropriate within each of these settings. As indicated, this may well vary between pupil, teacher and parent within each context.

They also differ in terms of control. This operates both at the level of specific activities and more strategically in terms of what is to be learned. In classrooms a great deal is increasingly pre-specified externally, through the National Curriculum, examination board requirements and in some curriculum areas, centrally generated timetables and lesson structures.

In the home setting, parents and/or children have far greater control, but here too there are increasing external pressures. These include direct Government exhortation, teacher advice and a burgeoning list of 'how to help your child do well in school' books.

The ways in which time is segmented are also important. In secondary schools in particular the structure of the timetable is likely to promote short rather than sustained activities. This in turn may well emphasise low-level tasks, which can often be completed quickly, and are pre-specified and closely timed. Conversely, higher level tasks, by their nature, tend to be harder to cater for within a pre-set schedule of short periods.

Four main patterns of teacher (or parent) and pupil links can be usefully distinguished:

- Pupil, teacher engaged in individual one to one learning activity
- Pupil, teacher and other pupils engaged in whole-class teaching and learning
- Pupil working with other pupils in a group activity
- Pupil working alone as an independent pupil.

Finally, in the pre-IT home and classroom, learning resources in schools have almost always been far richer and diverse than what was available at home.

Overall, what is striking is that the pattern of opportunities and limitations in the home appears to be pretty much the mirror image of that in schools. This has considerable implications for any attempts to create and develop home-school partnerships.

Changes needed to accommodate the use of stand-alone ICT equipment and resources

Introducing stand-alone ICT resources makes an impact upon this general framework, but what that impact is varies not only between the various groupings and settings described above, but also with the kinds of software and hardware being used. This presents teachers with an extremely complex innovation to introduce, as there are at least 20 completely different kinds of software packages in use in schools. These vary in the attainments they can support, the kind of classroom activities to which they contribute, and the demands they make upon the prior knowledge and skills of teachers and pupils. (Scrimshaw, 1997a).

In addition, the types of hardware now available for school use are almost equally diverse. Palmtops, laptops and stand-alone desk machines all have different possibilities, and within each of these categories there are important differences in functionality and ease of use too.

However, even this detailed specification is still couched in generic terms; what collecting or analysing data actually involves varies considerably from one curriculum subject to another. For primary teachers in particular this adds another whole level of complexity.

The key equity issue in schools is not access to resources but access to learning success. However, the extent and quality of this learning depends upon a number of factors. These can be best approached by asking, when using stand-alone ICT whether there are any thresholds below which the presence of stand-alone ICT has no impact on learning.

While we cannot identify any quantitative level for such thresholds, it is possible to make more explicit what factors appear to have thresholds, and in broad terms their relative importance as obstacles to success. It is clear that there are a number of largely separate thresholds, all of which have to be exceeded if learning is to occur. The precise level of these thresholds depends on the specifics of the software, teachers, pupils and context in which the learning is being attempted. Table 2 offers a speculative picture of the broad structure of the problem.

Achieving learning with any given system requires meeting minimum thresholds for…	**Level needed**	**Level required can be reduced by…**
Learning time	Variable	Probably no reduction possible for given pupil
Mechanical reliability	Very high	No reduction possible
Capital costs for school	Low	Well-funded school/strong ICT commitment
Running costs for school	Low	Well-funded school/strong ICT commitment
Operational intelligibility	High	Teacher's, parent's and pupil's prior knowledge
Pedagogic intelligibility	High	Prior training and/or redesign of documentation/system itself
Perceived educational relevance	Very high	Training and/or changes to documentation/ system to make relevance more obvious
Actual educational relevance	Very high	Policy of dumbing down
Provoking unplanned learning by teachers	Low	Encouraging more proactive and exploratory approach by teachers or parents
Provoking unplanned learning by pupils	Low	Encouraging more proactive and exploratory approach by teachers or parents and pupils

Table 2: Speculative view of minimum threshold levels needed to achieve learning, and possible modifiers of these levels

Learning time is the time that a pupil has spent on a given and accurately conceived learning task. It does not therefore equal the time the teacher allocates to the pupil for the task, as much of this may actually be off-task. Nor does it equate with the time that a pupil thinks they are on task, as they can actually be misperceiving what is required, and be engaged only in conscientious 'busyness'. In the case of computer use it certainly does not equate with the time that a pupil is in front of the computer. Two other problems in conceptualising learning time where computers are involved are that there may well be effects on learning away from

the computer as a result of its presence. In the extreme case, groups working away from the computer may benefit from some prior computer-based work in ways that are hard to identify clearly. Finally, joint use of a computer may increase or decrease the learning time achieved by each pupil involved, depending upon how well each can work independently and/or co-operate with others.

Mechanical reliability, the capital and the running costs for the school are reasonably self-explanatory, although in the case of the last, costs are far from easy to establish accurately.

Operational intelligibility refers to how easily the teacher and pupils can envisage how to mechanically use the system involved. (Much software package training and many 'how-to' manuals are concerned largely with this).

Pedagogic intelligibility refers to the ease with which teachers and pupils can see what classroom activities they respectively need to carry out to use this particular system successfully (i.e. in what ways their methods of teaching and learning have to change to make the most of this new resource). This is not a once-for-all threshold, as systems differ in how such understanding does or does not emerge over time as the users explore the possibilities.

Perceived educational relevance is similar, in that this refers to what educational point the teacher and pupils see in the system. If the teacher sees none, then the system fails at the outset, as it is not even tried. Similarly, if pupils cannot see the educational point of the system, they are likely either to use it without great interest, or to make determined but ill-informed and thus relatively unsuccessful attempts to learn.

Actual educational relevance is rather different, as this refers to the actual effects on learning of an activity. The only situation in which the system can be used successfully for any length of time is that in which it is both consistently perceived as educationally valuable, and where this perception is actually correct.

But taken alone, a concern for perceived relevance gives an unproductive over-emphasis to pre-specification. Systems also vary in what Jeremy Bentham might have called their fecundity in use; that is to say (in this context) their capacity for provoking unplanned learning by teachers and/or pupils. This is extremely important, as such unanticipated learning creates significant growth points, and lead to changes that affect how a wide variety of things may be subsequently learned. (If use of the printing press had been postponed until it was clear exactly what would be learned from it, then we would never have started to use it at all).

What further changes are needed to accommodate the use of networked technologies?

As the use of computers in schools has evolved, stand-alone computers have been increasingly supplemented or replaced by networked systems. In some respects this has merely changed the way in which the same resources (such as software) can be obtained and subsequently accessed. In these cases, pupils' activities around a networked computer are very much as they are for a stand-alone computer. However, as we have indicated in Study 1, the introduction of networked computers also opens up quite new educational possibilities too.

The definition we are using for networked technologies is that:

> 'networked technologies comprise those systems and networks that enable pupils to use e-mail and file transfer, computer conferencing, video conferencing and to create and access web pages.'

Networked technologies are different from stand-alone systems in that they are essentially either time and space manipulators or a means of accessing very large amounts of resource. Given the constraints that time, space and lack of resources place upon current classroom practices, this means that systems that can function in this way could prove to be very powerful agents for supporting or channelling change in the classroom and home.

They also change – or even reverse – the roles of teacher and pupils, as well as changing what resources either or both have access to, and in which 'physical' and cultural contexts the learning and teaching take place.

Which of these changes are potentially possible varies from one kind of networked technology to another (see Table 3).

Network-based activity	**Temporal characteristics**	**Spatial characteristics**	**Who counts as learners and teachers**
Accessing Web pages	Available asynchronously	Obtaining resources from a distance	Resource author acts as an additional non-interactive 'teacher'
Creating Web pages	Available asynchronously	Creating resources to be used at a distance	Learner acts as 'teacher' of others
Transferring files	Available asynchronously	Transferring resources across a distance	File provider acts an non-reactive 'teacher'
E-mailing	Asynchronous discussion with chosen respondents	Creating discussions at a distance	Additional teachers and/or learners become available at a distance
Computer conferencing	Asynchronous discussion with chosen and unchosen respondents	Creating discussions at a distance	Additional teachers and/or learners become available at a distance
Video conferencing	Available only synchronously with (usually) chosen respondents	Quasi face-to-face discussion	Additional teachers and/or learners become available at a distance

Table 3: Networked technologies; spatial and temporal and teacher/learner characteristics

Clearly, introducing these new technologies will mean that the demands upon the teacher will evolve, leading to a need to develop and extend their existing professional capabilities and to develop new ones. It is also clear that there is the potential for relationships between home and school, and thus between pupils, teachers and parents also to change. What then will these changes involve?

The Internet and the teacher's role

The first difference is that networked technologies greatly increase the range of knowledge available to learners through the Internet. This alone changes the teacher's role. How, for instance, does the teacher respond to a situation where different pupils have based individual

project work not upon the information contained in books in the classroom or school library, but upon data gathered electronically from outside sources that, in total, are too many and diverse for the teacher to check directly for accuracy?

Electronic networking also widens the range of learners in a group far beyond the classroom walls, through computer conferences and e-mail. But when the group with which a learner interacts includes other learners from all around the world, the teacher's contribution to the group's discussion is quite different from that which is possible and required when everyone involved is present in the classroom.

Such networking also expands the range of 'teachers' available to children. These include not only those fellow learners elsewhere who can advise their peers on a particular topic, but adult experts. This raises the question of how, for instance, the teacher contributes to a discussion on science between pupils and a working scientist whom they have contacted for advice, or how two teachers in different countries jointly organise and support a shared project involving both their classes. Where two classes in different places are involved this also introduces new forms of team teaching and 'classroom' organisation for the teachers of those classes

The opening up of home-based learning opportunities creates further pressures for change upon teachers. Parents are in some ways uniquely well placed to help pupils but will often lack key skills and knowledge to provide this help most effectively. E-mail and conferencing again provide teachers and parents with a new means of communication with each other, while Internet and intranet links can give parents better access to the tasks and resources that their children are working on. But this development too makes it harder for the teacher to keep track of what pupils are learning and with whom.

In Impact2 we will see something of how schools and teachers respond to these new possibilities. The first option is that some may simply view Internet resources as something to be closely controlled by the teacher, setting closed tasks that require only materials which the teacher already knows to be available on the Internet. This will require teachers to become familiar with what is available, and to develop their own skills in evaluating and assessing these resources. Alternatively they could decide to accept resources approved by someone else outside the school.

A second possibility is that resource selection takes place at the school level, through selective transfer of Internet resources to the school's own intranet. This would require school-level organisation, perhaps through the library or at departmental level, combined with facilities for staff to jointly evaluate, develop and extend the resources provided.

A third approach is to combine this sort of structured intranet provision (for pupils, parents and teachers) with access to the wider Internet. Here the intranet is used as a scaffolding device to build skills and confidence and a capacity to discriminate as a first step towards developing fully independent learning using Internet resources carefully selected by the pupil rather than the teacher.

Finally, a fourth possibility is for schools to take a much more process-focused approach, seeking to assist pupils in carrying out their own independent research from the outset. Schools taking this route will need to teach the processes of learning rather than its products. For both the third and fourth options, the conventional learning skills, such as locating,

collating and summarising information, and identifying connections and contradictions within a body of information, will all need to be explicitly moved to the centre of the classroom curriculum.

Electronic communication and the teacher's role

If we turn to e-mail and conferencing, it is clear that a major contribution from the teacher will need to be to assist learners to find out how to collaborate with and learn from others. This requires the explicit teaching and learning of ways of organising co-operative activities involving computers, whether face-to-face groups round a single machine or through co-operation at a distance via a conferencing or e-mail system. In addition, if parents are to be more usefully involved in their children's learning, they too will need assistance. If teachers provide this then this too has a time cost, as will the ongoing requirements of (for example) e-mail contacts between parents and teachers.

In order to do this, teachers themselves need more opportunities and support in using the new technologies in collaborative contexts, so that they can both identify the problems and possibilities for themselves and find ways to model these activities in their own practice with learners. Finally, when introducing these newer technologies teachers too need time to reflect upon and research what is happening. This implies that training will be a major issue if these innovations are to be introduced successfully.

What all this suggests is that introducing networked technologies to schools and to the wider community will demand a major reappraisal of the teacher's role, requiring a fundamental and continual process of rethinking what is taught, how it is taught, to whom, by whom and why. Teachers will need opportunities and support in developing forms of reflective classroom practice that enable them to make the best use of the educational and professional opportunities that will arise.

Converging contexts, converging technologies?

The networked technologies support, though they do not require, closer links between school and home and more specifically between teachers and parents. This may blur the distinctions between their respective roles as far as pupils' learning is concerned, and also raises the question of how the balance of control over the learning will be distributed between parents, teachers and the pupils themselves. Three possibilities indicate something of the range of practice that may emerge over the life of the Project.

One emerging model is the provision of school laptops (or low-cost dedicated word processors) to pupils to act as portable containers in which they carry instructions and work between home and school. This arrangement seems likely to leave control over learning and teaching very largely with teacher.

A second model, which is also in existence already, is that in which computers in the school and home are linked through some form of network, usually the telephone system. Here, all the equipment may be provided by the school, or the home computers may be owned by the family. Given that this system is essentially interactive and often with distributed ownership, this seems likely to lead to a more even and negotiated distribution of control between home and school. How control is distributed within the home between parents and their child (and, even more interestingly, between their children) is a further issue.

Finally, we can perhaps see the beginnings of a still more radical model of home-school linkage. As the mobile phone develops, it is becoming very widely available. Furthermore, it is already building in more and more of the features of a networked computer to add to its original function as a voice communication device. There are already mobile phones, which allow the owner to send and receive e-mails and to access the Internet through the phone itself. There are probably ergonomic constraints on what can be successfully combined in this sort of device, but within a few years schools may be able to rely on large numbers of pupils bringing in their own portable technologies to access the Internet. In Impact2 we may find that the schools have a variety of attitudes to such personal technologies (which could include palmtops, notebooks and laptops as well as mobile phones). The attitude of a school to the educational role of pupil-owned technologies (and how it deals with the related issue of equity of access to learning achievement) may turn out to be important to our study before the end of the two years.

3. Pupils, teachers and networked contexts: what is already known?

> 'The number and dynamics of factors that interact and affect the process of educational change are too overwhelming to compute in anything resembling a fully determined way. We do know more about the processes of change as a result of the research of the 1970s and 1980s, only to discover that there are no hard-and-fast rules, rather a set of suggestions or implications given the contingencies specific to local situations. In fact, (…) the uniqueness of the individual setting is a critical factor – what works in one situation may or may not work in another. This is not to say that there are not guidelines, and we will get to some of them. Research findings on the change process should be used less as instruments of "application" and more as means of helping practitioners and planners "make sense" of planning, implementation strategies, and monitoring. It is also important to say that this is a possible task: "Schools, classrooms, and school systems can and do improve and the factors facilitating improvement are neither so exotic, unusual, or expensive that they are beyond the grasp of (…) ordinary schools"'

(M. Fullan with Suzanne Stiegelbauer (1991) p.47.)

What is already known about these matters?

Pupils' attainment in any classroom may be affected by a number of factors, irrespective of whether or not ICT is used to support teaching and learning. For example, Taylor *et al*. (1974, cited in Collins, Hammond & Wellington, 1997) in listing the constraints on the curriculum included factors relating to the teacher, such as training, the pupil, such as prior experience, and the context in which learning may take place, such as levels of resourcing. Even where an innovation includes increased use of technology, other changes are often introduced at the same time (Chang *et al*., 1998). In such cases improvements in attainment cannot be attributed to the introduction of new technologies alone.

Research on the use of stand-alone ICT and networked ICT in classrooms suggests that many of the factors listed by Taylor *et al*. may have an effect on attainment but that some may have a greater impact than others. These factors have been referred to in a number of key research documents evaluating the effectiveness of ICT in the classroom and published in the last decade including: ImpacT (Watson, 1993), the EDSI evaluation (Scrimshaw, 1997b), an

evaluation of the Anytime Anywhere Learning Pilot Programme (Passey *et al*., 1999), a US study (Mann *et al*., 1999) and a report on effective pedagogy for ICT in primary literacy and numeracy (Moseley, Higgins *et al*., 1999). A literature review on INSET for IT (Harris, 1999a) also summarised the factors that may relate to the use of IT in the classroom. Table 4 summarises our first attempt at specifying these factors, which are discussed in more detail subsequently.

TEACHER
- ICT training
- Access to ICT for personal development
- Technical/pedagogical support
- Confidence in classroom use of ICT
- Attitude to ICT in classroom
- Competence in classroom use of ICT
- Pedagogical practices

PUPIL
- Nature of use
- Access
- Pupil characteristics

CONTEXT
- Amount of access
- Organisational structure of school and support

Table 4: Contextual factors involving stand-alone or networked ICT reported to affect attainment

The teacher

The factors concerning the teacher can be reviewed by considering those that relate to training and support, those that relate to confidence and attitude and those that relate to pedagogical practice. These may be interrelated, and each covers a number of more specific elements (Table 5).

TEACHER
- ICT training
  - Technical skills
  - Pedagogical skills
  - Quality, model, location and amount of training provision
  - Relevance to pedagogical practice
- Access to ICT for personal development
  - Time
  - Availability of resources
  - Location (school/home)
- Technical/pedagogical support

LEA advisors
ICT co-ordinator
Peers
Others
Confidence in classroom use of ICT
Technical use
Pedagogical use
Attitude to ICT in classroom
Perceived value of use
Influence of national, LEA and school policies
Curriculum requirements
Competence in classroom use of ICT
Experience of ICT (technical skills, pedagogical skills)
Ability to set clear learning objectives and communicate them to pupils
Pedagogical practices
Educational philosophies
Teaching styles/strategies
Beliefs
Classroom management

Table 5: Teacher factors involving stand-alone ICT or networked ICT reported to affect attainment

Training and support

Training in the use of ICT in the classroom, whether stand-alone or networked, is considered to be of great importance for the integration of this innovation in the classroom (see Harris, 1999a for a review of this, and for a mathematics-specific study, Wenglinsky,1998). It has been suggested (Watson, 1993; Scrimshaw, 1997b) that technical skills relating to software and hardware are essential but that training should also address pedagogical skills relating to the use of ICT in the classroom including classroom organisation, management and teaching styles. There are a number of issues relating to the technology itself and the kinds of software that can be used in the classroom that highlight the importance of regular and relevant training. The rapid pace of technological change may require teachers to continually update their skills and knowledge of ICT (Peha, 1995). A lack of understanding of the underlying philosophy of any software could limit the effectiveness of its use (Watson, 1993; Gardner *et al*., 1994; Schacter and Fagnano, 1999). Some technologies may place an emphasis on particular pedagogical skills. For example, computer conferencing can require a teacher acting as a moderator to be skilled in promoting discussion and devising activities that encourage it (Romiszowski and Mason, 1996). Irrespective of the kind of technology or specific software to be used, training should be relevant to the context of classroom use and teachers' practice (Scrimshaw, 1997b; Moseley, Higgins *et al*., 1999).

Teachers can build upon their training experiences through opportunities to access ICT resources. This can enable them to develop the required skills, explore the possible educational uses and locate suitable curriculum resources on the Internet (McMahon and Duffy, 1993; Becker, 1994). However, teachers may be restricted by availability of resources either at school or at home and competing demands on their time such as personal workload (Galton *et al*., 1997). The provision of portable computers for teachers can improve access and support professional development (Harrison, 1997; Galton *et al*., 1997). Williams *et al*. (1998) found that teachers who used computers at home tended to use ICT more frequently in school than their peers without access to technology in the home. As well as access, both the support of other computer using teaching staff (Becker, 1994; Peha, 1995) and professional ICT support and advice (Williams *et al*., 1998; Ofsted, 1998) are also important.

Confidence and attitudes

Confidence in the use of ICT may affect levels of use in the classroom and is itself affected by levels of training and support, and teachers' attitudes to technology. A survey of ICT in both secondary and primary schools (DfEE, 1999) reported that at least 65% of teaching staff felt confident about using technology in the classroom. Teachers' confidence can relate both to their own competence in the use of technology and to their perceptions of possible educational benefits. For example, teachers' lack of confidence in the educational use of e-mail is considered to be one factor impeding its uptake in schools (Becta, 1999). The attitudes of teachers to ICT can be influenced by other teachers, school managers, LEA support, and local and national policies and initiatives (Harris, 1999a) and may affect the benefits gained through the use of ICT in the classroom (Scrimshaw, 1997b; Scott *et al*., 1997).

Teacher competence in ICT use and pedagogical practices

Teachers need to be competent in their use of ICT in the classroom (Becker, 1999) and this is related to training, support, attitudes and confidence.

Children may achieve substantial gains in attainment partly due to the teacher's ability to set clear subject-focused learning objectives that are appropriate for ICT activities (Moseley, Higgins *et al*., 1999; Passey *et al*., 1999). This is considered to be necessary in networked ICT environments in order to avoid aimless browsing of the Internet (Scrimshaw, 1997b; Nicholls, 1999) or to prevent students from becoming overwhelmed by the quantity of resources available (Follansbee *et al*., 1997).

Passey *et al*. (1997a) suggested that educational benefits are linked to a teacher's ability to integrate networked ICT resources with other classroom-based resources rather than by substituting traditional methods with technology. To succeed in this, teachers may need to understand the underlying philosophy of the software and be willing to experiment with it (Watson, 1993). They may also need to recognise that in some cases the nature of the task might have to be altered (Passey *et al*., 1999) and that teachers may need to take a more flexible approach to how and what they teach when using ICT (Becker, 1994). However, teachers' prior practices are considered to be influential and often do not change radically when ICT is introduced (Miller and Olson, 1994). Moseley, Higgins and their team (1999, p.97) suggest that:

> Teachers who favour ICT are likely to have well-developed ICT skills and to see ICT as an important tool for learning and instruction. They are also likely to value collaborative learning, enquiry and decision-making by pupils. Teachers who have reservations about using ICT are likely to exercise a high degree of direction and to prefer pupils work individually.

Becker commented (1999) that teachers who adopt constructivist philosophies may make greater use of networked technologies. In contexts that involve more than one teacher, the compatibility of their pedagogical practices and teaching styles may be important – as, for example, when using video conferencing to enable two groups of children from different classrooms to collaborate on a task (Eales *et al*., 1999).

The pupil

The factors concerning the pupil can be reviewed by considering those that relate to the nature of use of the technology, those that relate to the amount and location of access and

those that relate to learning style or learner characteristics. These too can be specified in more detail (see Table 6).

PUPIL
- Nature of use
- Communication (with teachers/experts/peers)
  - To obtain information
  - Open-ended exploratory use vs structured task
  - Collaboration
- Access
  - Time
  - Quality
  - Location (school, home, other)
- Pupil characteristics
  - Motivation
    - Attitude to use of ICT
    - Competence in ICT use
    - Gender

Table 6: Pupil factors involving stand-alone or networked ICT reported to affect attainment

Nature of use

Networked technologies facilitate both communication between teachers, pupils and experts and easy access to information. Using the Internet may require a greater emphasis on developing pupils' skills such as critical thinking and problem solving (Owston, 1997). Passey *et al*. (1997a) argued that one factor relating to increased attainment is the use of networked ICT resources to enhance cognitive processes such as reasoning using, for example, e-mail or conferencing facilities.

As well as having clear learning objectives, the structure of the task and whether or not pupils collaborate may affect learning outcomes. Where the underlying processes, rather than just the outcomes, are important objectives these are more likely to be achieved where they are clearly articulated by the teacher and shared with the pupils (Bonnett *et al*., 1999). Watson (1993) considered that the use of stand-alone ICT for open-ended activities was beneficial, enabling pupils to experience challenging and complex tasks. The first ImpacT team also suggested that increased student control in exploratory tasks was one factor that positively affected learning outcomes. Yeoman (1996) suggested that open-ended tasks in computer conferencing environments are more successful than highly structured tasks in stimulating higher order thinking. This study concerned students in higher education but could also be relevant to secondary education. However, open-ended tasks do not seem to be successful in all contexts. Riel and Levin (1990) argued that a well specified task conducted by a group is more effective in a networked learning community than open-ended and informal communication via one-to-one e-mail chats.

Watson and her colleagues (1993) suggested that collaboration was an important aspect of stand-alone ICT use although some children in their study found this approach difficult, while Sears (1998) suggests that peer tutoring across year groups can also be beneficial. In a review of research on the effectiveness of ICT in schools, the Software and Information Industry Association (1999) concluded that collaboration across classrooms using networked ICT can improve academic skills and noted the importance of training children in collaborative skills.

Access

The amount of access to ICT by pupils is thought to be one of the most important factors affecting the impact on attainment (Watson, 1993; Moseley, Higgins *et al.*, 1999). Access to ICT in the school environment may be constrained by a number of contextual factors. Access to ICT in the home environment may contribute to an increase in attainment through strengthening the home-school link.

Little research has been published on the impact of ICT use in the home on children's learning. Home use of ICT is reported to have a stronger effect on pupils' attitudes to technology rather than school use (Martin, 1991; Kirkman, 1993). Selwyn (1997) concluded that access to stand-alone ICT in the home does not have any effect on levels of school use but does improve students' attitudes to ICT, particularly levels of anxiety and perceived usefulness.

ICT in the home could increase access and thus may affect children's competence and confidence levels (Peter D. Hart Research Associates, 1999). Factors affecting the amount of access at home to stand-alone ICT include its location in the home, ownership and rules about use (Downes, 1998) and these can equally be applied to networked ICT. For example, parents may give priority to work or educational related uses or restrict the amount of time allowed for playing computer games. The children in this study reported that they accessed their home computer more often than the school computers, with most preferring to use them in their home environment because it was better resourced, quieter and they were in control (Downes, 1998).

The most common use of ICT in the home environment is reported to be for non-school related tasks (Peter D. Hart Research Associates, 1999). The NOP research group (1999) reporting on a survey of British children's use of the Internet suggested that 46% of children have used this technology to look for things to purchase. Downes noted that (p.65) 'while game playing remained the more common activity, many of these children [in the study] regularly engaged in writing and drawing activities and used information-based programs for leisure as well as school-related work.' Some of these children perceived that game playing had an impact on their learning, from developing general computer skills to improving their problem-solving skills. Sanger (1997), in his research on computer games in the home environment argued that this type of use is not anti-social: rather that it promotes social interaction through collaboration on problem solving and discussion of strategies and new games. With networked ICT, children are now able to collaborate with their peers in any geographical location. Sanger also noted that children playing computer games were motivated, concentrated intensely and that the degree of engagement with the tasks involved was striking.

Pupil characteristics

The impact of stand-alone ICT on pupil motivation and attitudes to learning is widely reported (see for example Watson, 1993; Scrimshaw, 1997b, Cox, 1997). The motivating effects of ICT may have a positive impact on the status of the subject in which the technology is used, pupils' levels of concentration and time on task (Watson, 1993). Cox (1997, p.23) concluded that the research literature provides 'substantial supporting evidence that a range of IT uses have a motivating effect on learners in terms of enhancing students' enjoyment and interest in learning, self-directed independent learning, enhanced self-esteem, and enhanced potential for achieving longer term goals'. The results of Cox' s study suggested that pupils perceive that IT in learning has a positive effect on attainment as well as developing useful

skills for the future. Research on the impact of networked ICT has reported similar effects (Peha, 1995). IT use can also improve test results by reducing pupils' anxiety about a subject such as mathematics (Wittman *et al*., 1998). In contrast, Eales and colleagues (1999) reported that the potential benefits of video conferencing can be outweighed by pupils' self-consciousness, particularly in secondary education, when their awareness of self-image develops.

Moseley, Higgins *et al*. (1999) argued that teaching pupils ICT skills is important in ensuring that the subject-focused learning objectives of ICT activities are met, thus positively affecting attainment. Pupils also need to develop network literacy skills for research and the creation of web-based resources (Scrimshaw, 1997; Wyld and Eklund, 1997). They need to develop skills to critically evaluate and select appropriate resources (Peha, 1995). There are also indications (Littleton *et al*., 1998) that the relative performance of boys and girls tends to be affected by the choice of imagery when designing educational software.

The context

The factors concerning the context can be reviewed by considering those that affect access to the technology and those that relate to the school as a whole, such as organisation and underlying educational philosophies. (The factors are specified in more detail in Table 7.)

- CONTEXT
  - Amount of access
  - Curriculum requirements and assessment
  - Time-tabling
  - Resourcing
    - Funding and conflicting school needs
    - Number of machines
    - Reliability
    - Costs
    - Technical limitations
    - Ease of use
    - Applicability to curriculum requirements
    - Underlying educational philosophy
    - Pace of technological change
  - Organisational structure of school and support
    - Dominant educational and social philosophy
    - Other educational innovations

Table 7: Contextual factors involving stand-alone or networked ICT reported to affect attainment

Access at school

The demands of the National Curriculum and preparing children for formal assessments such as GCSEs can restrict the opportunities for integrating ICT into classroom practices (Watson, 1993; Nicholls, 1999). Evidence suggests that effect on attainment differs according to the subject area in which ICT is used (Watson, 1993; Becker, 1999; Software and Information Industry Association, 1999) and also the kinds of technology used (Software and Information Industry Association, 1999). Different networked technologies may be more appropriate for different subjects.

The constraints of timetabling, particularly in secondary schools, have been noted by researchers. This factor becomes even more important in video conferencing, when co-ordination between two or more schools is required (Galton *et al*., 1997; Higham *et al*., 1997). Wyld and Eklund (1997) comment that the amount of time available for pupils in their research dedicated to use of the Internet was restricted and may have restricted the learning outcomes. The fragmentation of subjects and short teaching periods can constrain the effectiveness of ICT use (Barchechath *et al*., 1998; Nicholls, 1999) although in primary education there may be more opportunities to spend longer on ICT-related tasks. It has also been reported that many students perceive that the number of occasions in which teachers make use of ICT to support teaching and learning in particular subject areas is rare (Peter D. Hart Research Associates, 1999). When ICT is used in the classroom it is mainly either word processing or for research.

The quantity and quality of ICT resources may also have an effect on access (see for example Peter D. Hart Research Associates, 1999). For example, in the Birmingham Knowledge Superhighways project in which the main focus was video conferencing, it was considered that a single system was not sufficient to stimulate the interest of staff (Galton *et al*., 1997). The levels of resourcing, both physical and financial, are considered to affect the contribution of networked ICT to improving teaching and learning (Scrimshaw, 1997b; Wyld and Eklund, 1997). Expenditure on computers for supporting learning in schools is increasing, and 63% of primary schools and 93% of secondary schools now have access to the internet (DfEE, 1999). Furthermore, the ratio of pupils per computer has fallen from 18 in 1998 to 13 in 1999. Until recently schools, if they have had access to networked ICT, have generally had only one e-mail account and thus a single identity (Davis, 1997) constraining its use in the classroom and creating management problems. The limited number of Internet connections in a school can affect access (Wyld and Eklund, 1997; Nicholls, 1999) as can the costs involved in using networked ICT (Hall *et a*l., 1997; Louis, 1997; Owston, 1997). Internet access to resources can be time consuming (and therefore costly) if traffic on the superhighway is heavy (Owston, 1997; Passey *et al*., 1997b; Becker, 1999; Wishart and Blease, 1999). Poor reliability is commonly described as a barrier to effective use of ICT, whether stand-alone, portable (see for example Gardner, 1994) or networked (Owston, 1997, for example, or Nicholls, 1999; Eales *et al*., 1999).

The location of ICT resources in school can have some bearing on the benefits to be gained (Scrimshaw, 1997b). Teachers are more likely to incorporate ICT in their teaching and learning if it is available in their classroom rather than in computer labs (McMahon and Duffy, 1993; Becker, 1999). With regard to networked ICT provision, the compatibility of the school's systems with those of other organisations or individuals is also an issue that should be considered (Scrimshaw, 1997b). In video conferencing, the background noise that is common in classrooms can be a problem (Eales *et al*., 1999).

Home-school links

The use of portable technologies can enhance learning indirectly by enabling challenging homework tasks to be set and facilitating a degree of individualised learning (Passey *et al*., 1999). Passey and his team also noted that the provision of individual laptops for pupils can contribute to the development of parental involvement with pupils' learning and the school. Stradling, Sims and Jamison (1994) in their evaluation of the portable computers pilot project for NCET (now Becta) noted that parental support was considered to be a key factor in the effective use of portables at home. Monteith (1998) describes how parental involvement can be increased through discourse around the use of word processors in the home and notes that

children appear to have more control over their learning when in this environment than when they are in the classroom.

Gender too may be a factor, as gender differences have been noted (Harris, 1999b) in the proportional use of games and word processing at home. Access to networked ICT in the home environment has been linked to improvements in pupil attainments (Passey *et al*., 1997a) partly due to parental involvement and the opportunity to support the home-school link electronically. Two other studies (Wenglinsky, 1998 and Harris, 1999c) give qualified support to the the view that students who use computers frequently at home have higher levels of achievement in mathematics and science tests. McMahon and Duffy (1993) noted that children with access to networked ICT in the home were able to devote extended periods of time to homework. They also commented that networked ICT can contribute to improved home-school communication.

Organisational structure of school and support

Another important factor that could affect the impact of ICT in the classroom is the educational and social philosophies of the school (Scrimshaw, 1997b), such as, the school's approach to obtaining funding or their attitude to developing community links.

A number of researchers stress that the attitude of the headteacher to ICT in the classroom and the quality of management are important factors (Scrimshaw, 1997b; Williams *et al*., 1998; Harris, 1999a). The provision of technical support in a school can have an impact on how effectively a teacher uses ICT in the classroom (Moseley, Higgins *et al.*, 1999).

Summary

From reviewing the literature, it seems that the most important factors affecting the impact of ICT on pupil attainment are:

- Training for teachers both in technical skills and pedagogical uses
- The ongoing support of others including management and ICT using teachers
- Teachers' confidence in the use of ICT and their attitude to innovation
- Teachers' access to ICT
- Teachers' pedagogical practice
- Pupils' access to ICT for development of skills either at home or at school
- Pupils' competence in the use of ICT
- The availability and reliability of ICT resources either at home or at school.

It has been suggested that there may be a minimum threshold of access, experience and use of ICT for any impact on learning to be detectable (Watson, 1993) although these levels have not yet been defined.

4. Selecting the research instruments

Introduction: The hypotheses

In Study 2 the objective is to frame the key factors in the learning environment likely to have an impact on the effects on learning of networked technologies. In the light of the discussion in Study 1 and above, our view is that a number of factors will affect the learning outcomes. These fall into two groups: those centring upon the teacher and those centring upon the pupils. These hypotheses are listed in Table 8.

Teacher-centred hypotheses
Attainment will be affected by…
Differences in how teachers conceptualise networked technologies Differences in teachers' training and support in the classroom use of networked technologies. Differences in teachers' confidence in the use of networked technologies in classrooms, and attitudes to innovation generally. Differences in teachers' pedagogical practice, including the matching of learning objectives to the use of networked technologies, and the communication of this to pupils.
Pupil-centred hypotheses
Attainment will be affected by…
Differences in how pupils conceptualise networked technologies. Differences in pupils' access to networked technologies in their homes. Differences in pupils' access to networked technologies during classroom activities. Differences in pupils' access to additional curriculum resources through networked technologies. Differences in pupils' access to additional adult help through networked technologies. Differences in pupils' access to additional pupils through networked technologies.

Table 8: The Impact2 hypotheses

In many studies it is assumed that the effects on learning operate at a fairly gross level; i.e. that differences in attainment between, say, pupils using a computer and using a conventional resource to achieve the same objectives will be visible at that level of generality. However, as Study 1 has emphasised, there are a number of studies (see for example Olson (1988); Scofield (1995); Fisher (1997) and Wegerif (1997)) that offer a different view. They suggest that the impact of stand-alone ICT (and so by implication, possibly of networked technologies too) may be in part dependent upon the microstructure of the teaching and learning situations, rather than only upon the broader features of the situation. This is compatible with conclusions drawn from curriculum development research more generally. Precisely how a software package is used may be as important an influence upon what is learned as the fact that it is used at all. If so, this would explain why many studies fail to find significant effects, because the micro features that differentiate between classrooms or activities where effects are occurring and those where they are not are too specific to be picked up by the research design.

The hypotheses and the context instruments

This in turn implies that what is needed for the Main Study is an approach that combines ways of catching the broader picture (and within that, any major effects that are present) and also ways of obtaining the more intricate detail. The latter will also provide the team appointed to carry out the later case studies (known as Strand 3) with a conceptual framework that should assist them in designing their approach. It will also help achieve to some degree a mesh between the findings from that study and our own Main Study. Table 9 summarises the instruments that we intend to use to obtain context-related data on each hypothesis.

Hypotheses are that attainment will be affected by…	**Context Instruments**
Differences in how teachers conceptualise networked technologies.	REPRESENTATION Project Concept Mapping Task.
Differences in teachers' training and support in the classroom use of networked technologies.	NoF training status of teacher REPRESENTATION Project Concept Mapping Task. Availability or otherwise of school ICT development plan Teacher report
Differences in teachers' confidence in the use of networked technologies in classrooms, and attitudes to innovation generally.	NoF training status of teacher Teacher report Teacher Diary
Differences in teachers' pedagogical practice, including the matching of learning objectives to the use of networked technologies, and the communication of this to pupils.	Teacher report Teacher diary Pupil report Pupil diary
Differences in how pupils conceptualise networked technologies.	REPRESENTATION Project Concept Mapping Task.
Differences in pupils' access to networked technologies in their homes.	Pupil report Pupil Diary
Differences in pupils' access to networked technologies during classroom activities.	Teacher report Teacher diary Pupil report Pupil Diary
Differences in pupils' access to additional curriculum resources through networked technologies.	Teacher report Teacher diary Pupil report Pupil Diary
Differences in pupils' access to additional adult help through networked technologies.	Teacher report Teacher diary Pupil report Pupil Diary
Differences in pupils' access to additional pupils through networked technologies	Teacher report Teacher diary Pupil report Pupil Diary

Table 9: The hypotheses and the context instruments used for each

The REPRESENTATION task

Data on teachers' and pupils' understanding of the potential use of computing resources will be collected using the REPRESENTATION Project Concept-Mapping Task (Crawford, Neve, Pearson and Somekh, 1999; Pearson, Somekh and Neve, 1999). The method is described in detail in Study 1. In essence it involves asking respondents to prepare a network map showing a computer system in as much detail as possible. They are also asked to list the items in their map. In a separate session they are asked to explain, in writing, a computer system to a Martian, thus providing an independent check upon their conceptualisation. The network maps can be analysed quantitatively to show differences in the numbers of items distinguished and (through the number of links drawn to connect the items) the degree of interconnectedness that the pupils have in their understanding of such systems. In addition, all three kinds of data can be analysed qualitatively to show, for example, whether respondents see computer systems in purely stand-alone terms, or realise that computers can be linked together through, for instance, the Internet. These qualitative analyses will be carried out at a global level, to give four or five broad categories of conceptual complexity. These categories, together with the conventional attainment measures, will provide the baseline and outcome variables for the Main Study.

It would also be worth using a different version of the instrument selectively during the course of Impact2 to establish conceptual change in pupils' understanding of a substantive curriculum topic. We are likely to find that teachers have different approaches to setting up computer-mediated project work and it might be possible to get clear effects of different gains from different approaches. For example, if there was a project on Volcanoes pupils could be asked to produce a concept map of this topic before and after the project. This might, for instance, show a substantial difference between those who used the Internet to collect data and those who only used a word processor to write it up. We would use the same method for quantifying the difference between their two maps that we use to quantify gains in representations of ICT itself at the beginning and end of the evaluation.

To identify the teachers' representations of ICT and changes in these, we will ask teacher researchers to produce concept maps of their own understanding of ICT, before they get pupils to complete them. As part of their research role they could also be asked to get some of their colleagues to produce them as well. This exercise will be repeated at the end of the evaluation, giving us a measure of the impact of the project on their staff development. In addition teachers' concept maps would provide part of the context for the pupils' use of ICT (as teachers with very limited mental representations of ICT are unlikely to be able to use it effectively with pupils).

The pupil report

In addition to the REPRESENTATION task, we envisage using two instruments developed in partnership with student researchers, to provide data on students' evolving knowledge and skills, and how these are positioned in relation to the learner's sense of school and non-school culture.

Firstly, we envisage producing a pupil report. This will be a self-completion data-logging instrument which children could use to categorise their ICT use, say at the end of each evening at home. This would need to be very quick to complete, so we are thinking in terms of a pre-structured report which provides the pupils with 'slots' for free responses within a very tightly structured framework. This idea, taken from the use of writing frames in English

teaching, will greatly simplify analysis but at the same time avoids having to pre-specify a set of acceptable responses for each aspect of the report.

The pupil diary

Secondly, to supplement the pupil reports we could also ask some children to keep diaries for limited periods and purposes. This would produce much more varied data, but would be rich but time-consuming to analyse (so only to be done by selected pupils and to probe a particular issue or aspect of the situation).

The teacher report and teacher diary

As with the pupils, for the teachers we will need instruments developed in partnership with the teacher researchers, to provide data on the complex interactions between the learner's task, the learner's behaviour with ICT and learning outcomes. For this we envisage using teacher reports and diaries, designed and employed in broadly the same way as those already described for the pupils.

NOF training status of teacher

While the NOF data will provide baseline and outcomes measures, it will also have a role during the project, in relation to context variables.

During the course of the Project many of the teachers will complete their NoF-funded training. Their current status in that process (not begun/in progress/competed) is therefore a useful broad surrogate for their training level, at the start, the end and at intermediate points during the project. However, taken alone it is likely to be misleading as an indicator of competence levels, as for example a few project teachers may not even be put into the NOF training because they are already considered fully competent. This could be explored by looking at the individual teacher’s needs identification and training outcome data, which will be available in profusion, but numbers of training providers will be involved, each with their own approach, so comparing across them could be difficult and costly in time and effort. Conversely, some complex issues of confidentiality could arise if we wanted to use NOF’s own QA data. There are issues here we clearly need to consider further.

5. Conclusion

In summary, we are dealing with the introduction of a rather diverse set of complex technologies. These are being introduced into classrooms with considerable differences in teacher, pupil and resource related features. The networked technologies being introduced will also be directed to a variety of educational purposes, some of which will initially be apparently clear to the teachers involved, whilst others will be more hazily conceived.

In essence the research strategy is to use a graduated set of research instruments, varying in their level of pre-specification of acceptable data and in the mix of quantitative and qualitative data they will collect. In different ways, most of the context instruments, and some of the baseline and outcomes instruments allow the collection and analysis of data at a more or less fine-grained level. This will give us some room for methodological and analytical manoeuvre when (not if) the data from the teachers, parents and pupils begins to surprise us.

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These items were not necessarily seen by a member of the ImpacT2 team

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Note: The Becta Literature Review

This review (Harris, 2000) was commissioned by Becta independently of the Impact2 preliminary studies, and designed for a rather different purpose. It was, however, felt that some material from it could usefully be added to the studies. In Study 1 this has been done by inclusion of the appropriate items as a supplement to the tabulated review (Appendix A) while in Study 2 mention of the references has been incorporated directly into the text. As the items added were not studies that a member of the ImpacT2 team had necessarily seen, they are indicated by a hash mark in the Study 1 and Study 2 reference lists.

The review covers 44 studies, including some very briefly mentioned and labelled unsuitable for further consideration. Of the 44 studies, 13 have been added to Study 1 and 8 to Study 2. The remainder were excluded on one or more of the following grounds:

- Insufficient detail was given to identify the broad type of ICT involved and/or the effects on attainment
- They had already been included in Study 1 or Study 2
- A computer was used only in administration of tests, rather than being an element in the teaching/learning situation being tests
- Manifestly poor design.

The addition of these items did not change the general thrust of the analysis in either study, except to give a rather more positive picture of the value of conventional pre- and post-test studies as ways of identifying the impact of stand-alone IT on attainment. It did, however, lead to a reconsideration of our earlier decision to leave gender off the list of contextual factors in Study 2; this omission was also noted in the Expert Seminar. It is perhaps worth observing that only one of the items added to Study 1 is actually in the priority list of topics indicated on p35 of Study 2, the remainder being in the area of relevant related topics.

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