Measures for assessing the impact of ICT use on attainment

A report to the DfES by

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Executive summary

Building on ImpaCT2, this study aims to design a measure or measures capable of tracking 'snapshot' data, such that it will be possible to monitor the development of ICT use to support attainment.

ImpaCT2 and the aims of the study

In 1998, the Government launched its ambitious National Grid for Learning (NGfL) – now known as the ICT in Schools Programme. By investing £700 million in connecting schools, training teachers and librarians in the use of ICT, establishing a national agency to oversee the grid's development, and developing content, the Government aimed to introduce ICT as an integral part of teaching and learning. Fulfilling this potential is a major objective of the ICT in Schools Programme, as is the need to demonstrate the nature and extent of its impact on teaching and learning.

ImpaCT2 (Comber *et al*., 2002; Harrison *et al*., 2002; Somekh *et al*., 2002) was one of a number of projects commissioned by the Department for Education and Skills (DfES) to evaluate the gains associated with the introduction of the NGfL, and identify the factors that contribute to raising attainment with ICT. A conclusion that can be drawn from ImpaCT2 is the difficulty of establishing an exact causal relationship between use of ICT and attainment. Ideally a direct link could be made between the use of a given system or software application, an aspect of the curriculum and learning, and an assessment of the particular form of attainment that the ICT is designed to have an impact upon. Even then a range of other environmental, pedagogical, institutional and resource factors may impact on the process.

Building on ImpaCT2, this study aims to design a measure or measures capable of tracking 'snapshot' data, such that it will be possible to monitor the development of ICT use to support attainment in institutions over time. This includes differences in management and classroom practices and their effects on ICT and attainment. Based on a study of a representative sample of schools, which are both high and low users of ICT, this study intends to ascertain those aspects of resourcing, content, practice and other factors that play a part in governing the likely impact that ICT may have on attainment.

A framework for measures of attainment

Chapter 2 describes the twin-track approach taken by the study in constructing a set of 'snapshot' measures. One track involves identifying key factors from the literature on ICT and attainment related to teachers, learners and organisational issues. The other track puts these factors into a framework which systematically relates them to one another and to their potential impact on attainment. Finally the framework is applied to a range of teaching and learning situations as the basis for creating the 'snapshot' measures.

This study looked at three types of attainment connected to:

- *curricular knowledge* – the outcome of formal schooling, with ICT providing the means to gather information, develop new representations, and share information with other learners
- *ICT skills* that enable the processes associated with developing curricular knowledge (these ICT skills are also classed as curricular knowledge in the National Curriculum, but in this report they are treated as a separate category)
- *personal factors*, which include the development of self-confidence, motivation, autonomy and collaboration as learners use ICT. This is an area of attainment that is not recognised by formal assessment, but ICT has been identified as making a significant contribution.

The study focused on the role of ICT as it is currently used in learning, and kept in mind that the connection between curricular knowledge and the possibilities offered by ICT for affecting attainment is complicated. It is ICT's potential for helping learners to improve their attainment that this study makes its main concern.

At the heart of our approach is a model of teaching and learning derived from ideas in Activity Theory (see Appendix 1). The model sets the use of ICT in the context of the aims and outcomes of teaching and learning situations, and the ways in which the physical setting and

an activity's sequence and structure affect its successful conclusion. Figure 1 shows the three interconnected levels of the model: Purpose, Structure and Conditions.

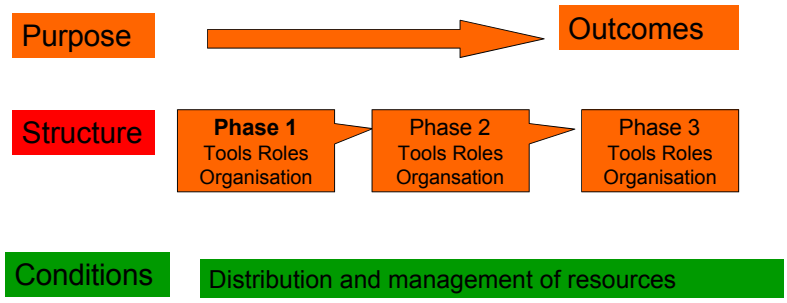


Figure 1: Model of teaching and learning used in the study

In this model, the chronological sequencing of an activity has an effect on its final outcome(s). Figure 1 shows three phases, corresponding to the introduction, main body and conclusion of a 'normal' teaching and learning activity. However, as the report shows, activities can have one, two or three phases depending their purpose. The study's intention was to develop measures related to the different levels of the model, which indicate the potential of an ICT-based activity to develop attainment.

Methodology for the study

Chapter 3 describes the approach that was taken in the study to collecting and analysing the data which was used as the basis for the measures. To analyse the range of possible factors and the kinds of relationships between the different dimensions of the model, it was decided to:

- collect data about a range of teaching and learning activities across a range of sites, including information about activity leaders and participating learners
- build and use a relational database to organise and analyse the data collected. With a relational database it is possible to summarise data about different levels in the model, and to construct relationships between the levels, which can be used to examine possible sets of indicative measures.

The overall strategy for the study had two strands. Strand 1 consisted of data collection and the construction of a database for actual teaching and learning situations. Strand 2 involved the systematic analysis of the factors which were relevant to the development of learners' attainment in the context of ICT.

To obtain data relevant to each level of the model, it was necessary to:

- interview activity leaders about the kinds of attainment, planned or otherwise, that have occurred as they engage in ICT-based activities
- observe activities, taking account of their sequencing, organisation, and the roles adopted by leaders and learners as they used ICT
- survey sites of activities and their participants to build up a profile of the background to the activities, and the conditions in which they occurred.

Details of how the data collected was organised and analysed using a relational database are in Appendix 2.

Two key questions were investigated:

- What were the characteristics of the activities, leaders, learners and sites, for each of the observed activities?
- For each activity that was judged to have achieved its outcomes, what were the particular characteristics of the activity, site leader(s) and learners?

Using information from the first question, our intention was to look for common characteristics of the activities. This would enable us to examine the second question and form a possible set of measures.

Developing a framework of measures

Twenty-four sites, of different types and sizes, in different locations, and with different socio-economic compositions, in and around Leeds, were visited between February 2003 and April 2003. Sixty-one activities were observed across all key stages, involving 48 activity leaders and 59 groups of learners. Full details of the sample and seven short case studies to illustrate the different kinds of attainment observed are found in Appendixes 3 and 4.

Chapter 4 presents the analysis of attainment that was undertaken, and the factors that could be used as measures of attainment. It consists of:

- an analysis of the different types of attainment and their connections with each other
- a measure for leaders' and learners' confidence in using ICT for teaching and learning, obtained from their profiles
- a measure which describes the structure of teaching and learning that took place, based on an analysis of the activities observed
- a measure of the 'potential for attainment' with ICT, given the configuration of hardware, confidence of the activity leader in using ICT, and type of teaching and learning that took place.

Using the 'potential for attainment' score we found that activities scoring the highest value across all four hardware configurations – single computers, groups (2–5 computers), suites (6–12 computers) or rooms (more than 12 computers) – had very similar characteristics:

- *Teaching and learning structure*: All the activities had at least two phases which started with a leader-centred approach and then switched to a learner-centred activity.
- *Teachers' confidence with ICT*: Three-quarters of the activities were led by people with considerable teaching experience, but less experience with ICT.

Findings and recommendations for further work

Chapter 5 presents the outcomes of the study, and makes recommendations for further work. This study proposes measures of:

- the extent to which an activity achieves its intended outcomes, taking into account the preparation made by the leader
- an activity leader's confidence and competence in using ICT for teaching and learning
- the structure of teaching and learning activities, which indicate the extent to which leaders enable learner-centred behaviour using ICT
- the potential for attainment with ICT.

Each activity was categorised according to the:

  - hardware configuration used
  - leaders' confidence score
  - structure of its second phase.

A 'potential for attainment' measure was obtained by multiplying the average attainment rating for a given category by the relative frequency with which that category occurred. (Details can be found in Appendices 5 and 6.)

Further work would enable an enlargement of the sample and period of data collection so that we could:

- check the measures for validity and reliability, since they are derived from the data collected

- check the validity and reliability of the judgements made by those who observe the activities
- analyse individual learners' attainment related to the various activities that they have participated in, using a value-added analysis of their curricular, ICT and personal attainment over a longer period.

Chapter 1: ImpaCT2 and the aims of this study

This chapter describes the context and aims of the study. ImpaCT2 and its background are outlined, together with some of its conclusions and their implications. The aims of this study are then summarised together with the general approach that it took.

1.1 The context for ImpaCT2

In 1998, the Government launched its ambitious National Grid for Learning (NGfL) – now known as ICT in Schools Programme. Investing £700 million in connecting schools via the NGfL, training teachers and librarians in the use of ICT, establishing a national agency to oversee the Grid's development, and developing content, the Government committed itself to introducing ICT as an integral part of teaching and learning. Fulfilling ICT's potential for improving teaching and learning is a major objective of the ICT in Schools Programme, as is the need to demonstrate the nature and extent of its impact on teaching and learning.

Many studies point to the positive benefits of using ICT in teaching and learning, both in terms of raising standards and improving motivation. Starting with the first ImpaCT study (Watson *et al*., 1993), evidence has accumulated to show how ICT can affect literacy and numeracy (Moseley and Higgins, 1999) as well as motivation (Cox, 1997). ImpaCT2 (Comber *et al*., 2002; Harrison *et al*., 2002; Somekh *et al*., 2002) was one of a number of projects commissioned by the DfES to evaluate the gains associated with the introduction of the NGfL, and identify the factors that contribute to raising attainment with ICT. Organised into three strands, ImpaCT2 aimed to:

- analyse the statistical relationship between the effective implementation of ICT and standards of performance in national tests and at GCSE (Strand 1 (Harrison *et al*, 2002))
- establish how pupils use ICT, particularly out of school, and what they gain from this use (Strand 2 (Somekh *et al*, 2002))
- explore the nature of teaching and learning using ICT in a variety of settings, focusing on pupils, teachers and managers (Strand 3 (Comber *et al*, 2002)).

ImpaCT2 took place between 1999 and 2002, and involved 60 schools in England. During this early to mid-period of the NGfL programme, resources were being introduced and training and support activities were taking place. Consequently researchers found that the proportion of lessons involving ICT was generally low.

Strand 1 of ImpaCT2 (Harrison *et al*, 2002) measured attainment in terms of pupils' relative gains in their formal examination scores when compared with those predicted for pupils with a similar profile. The gains were set against the degree of ICT use in the various settings. Strands 2 (Somekh *et al*, 2002) and 3 (Comber *et al*, 2002) of ImpaCT2 examined how ICT experience outside formal schooling can have an effect on pupils' attainment. Together the three reports suggest that children have a wide range of ICT experiences both in school and at home, often using equipment that surpasses what is available in school. Using qualitative data from the case study work in Strand 3 (*Ibid*.), including interviews with pupils and teachers, and pupils' and teachers' log books, ImpaCT2 tried to explain the complex pattern of results.

1.2 What ImpaCT2 tells us

Strand 1 (Harrison *et al,* 2002) showed a variety of positive results across different key stages and subjects. There was also variation in the outcomes, which did not display a consistent pattern and raised a number of questions about the relationship between attainment and ICT.

A conclusion that can be drawn is that it is difficult to establish an exact causal relationship between ICT experience and attainment. Ideally a direct link could be made between the use of a given system or software application, an aspect of the curriculum and learning, and an assessment of the particular form of attainment that the ICT is designed to have an impact upon. Even then a range of other environmental, pedagogical, institutional and resource factors may impact on the process.

Taken together, the three strands identify the significance of context in understanding the relationship between ICT experience and attainment. There are a number of issues that need to be addressed in evaluating ICT's *specific* role(s) in attainment, including the role(s) of the teacher, the level and rate of integration of ICT into pedagogical activity, and the relationship between content and its mode of delivery (OECD/CERI, 1999).

1.3 What this study is about

Building on ImpaCT2, this study aims to design a measure or measures capable of tracking 'snapshot' data, such that it will be possible to monitor the development of ICT use to support attainment in institutions over time. This includes recording differences in management and classroom practices and their effects on ICT and attainment. Based on a study of a representative sample of schools, which includes both high and low users of ICT, it intends to ascertain those aspects of resourcing, content, practice and other factors that play a part in governing the likely impact that ICT may have on attainment.

'Taking snapshots' in this study is interpreted as collecting information about factors that are identified as being important for ICT and attainment. On the one hand this meant identifying significant factors for the relationship between ICT and attainment, and, on the other hand, structuring those factors in a way that captures their interactions. As the preliminary study 2 for ImpaCT2 shows, there are a range of significant factors related to teachers, learners and organisational issues which affect attainment (Lewin *et al*, 2000b, p. 22). The study points to the interplay between these factors when integrating ICT into pedagogical activity. The key question is how this integration relates to attainment (Comber *et al*, 2002; Harrison *et al*., 2002; McFarlane *et al*, 2000).

The integration of ICT into teaching and learning can take a number of forms. On the one hand there is the 'vertical' integration of ICT into the curriculum, where the technology is the object of study, and development of skills is undertaken. On the other hand there is 'horizontal' integration where ICT is used during the process of learning curricular knowledge. For many, this latter case has the potential to transform teaching and learning, bringing new forms of knowledge and pedagogies (eg McCormick & Scrimshaw, 2001; Watson, 2001). However, others feel that this optimism is not borne out by evidence over the past 20 years (Conlon and Simpson, 2003; Reynolds *et al*., 2003).

As ImpaCT2 suggests, finding a direct link between ICT experience, obtained either through its vertical or horizontal integration into the curriculum, and attainment, as measured using national tests, is difficult. To that end, the measures developed in this study focus on:

- aspects of ICT that have the *potential* for improving attainment
- different kinds of attainment that ICT can have an impact on
- teaching and learning activities within a range of educational settings that shape the relationship between ICT and attainment.

Chapter 2: A framework for measures of attainment

A twin-track approach is taken in the study to constructing a set of 'snapshot' measures. One track involves identifying key factors from the literature on ICT and attainment related to teachers, learners and organisation issues. The other track puts these factors into a framework which systematically relates them to one another and to their potential impact on attainment. Finally, the model, consisting of key factors and the framework, is applied to a range of teaching and learning situations as the basis for creating the 'snapshot' measures.

This chapter describes the:

- types of attainment – related to curricular knowledge, ICT skills and personal qualities – used in the study
- range of key factors associated with ICT, teaching and learning that was used in the study
- framework employed to relate these factors in a systematic way to attainment. The framework brings together the two strands of data collection and analysis central to this study of ICT-based pedagogy.

The chapter concludes with suggestions for a range of measures associated with the study's framework, which could be used to examine ICT's potential impact on attainment.

2.1 What is attainment?

Usually attainment means 'achievement' measured against a set of criteria, which, in the National Curriculum for example, are set out in the level descriptors and programmes of study (TGAT, 1988). In this study three types of attainment were examined, connected to:

- *curricular knowledge* – the outcome of formal schooling, with ICT providing the means to gather information, develop new representations, and share information with other learners
- *ICT-skills* that enable the processes associated with developing curricular knowledge (these ICT skills are also classed as 'curricular knowledge' in the National Curriculum, but in this report they are identified as a separate category)
- *personal factors,* which include the development of self-confidence, motivation, autonomy and collaboration as learners use ICT. This is an area of attainment that is not recognised by formal assessment, but one to which ICT has been identified as making a contribution.

2.1.1 ICT and curricular attainment

ICT can make important contributions to children's attainment in literacy and numeracy (see, for example, Higgins and Muijs, 1999; Moseley and Higgins, 1999; Becta, 2003). ICT can enable learners to develop skills and knowledge that are laid down in the curriculum. For example, in literacy ICT can support learners as they develop skills of information exchange such as reading and writing. For numeracy, ICT can help children to calculate both orally and with paper and pencil.

This study focuses on the role of ICT as it is currently used in learning, and the complexity of the connection between curricular knowledge and the possibilities offered by ICT for attainment. It is ICT's *potential* for helping learners to develop their attainment which forms the main concern of the study, and the measures that it creates.

2.1.2 ICT skills attainment

In this study, the focus is on the development of ICT skills as well as their contribution to curricular knowledge. ICT occupies a place similar to literacy in the National Curriculum. It is considered both to be a body of curricular knowledge, and also something that enables children to learn other subjects. Having a range of ICT skills and understanding makes new kinds of knowledge available to learners. Understanding ICT's contribution to attainment involves taking account of how and when learners should have an appropriate grasp of the skills needed for learning to take place.

2.1.3 ICT and personal attainment

An area that ImpaCT2 does not explore in detail is the contribution of ICT experience to developing personal attributes, and their relationship with attainment. Investigating how these qualities are related to both personal attainment and curricular knowledge is explored in this study. In particular we wanted to examine the role that ICT plays in developing self-confidence (Watson *et al*., 1993; Wood, 1999), motivation (Cox, 1997), and the ability to work on one's own or with others (Crook, 1994; Noss and Hoyles, 1996; Underwood and Underwood, 1999; Cooper and Brna, 2001). Learners' attitudes and beliefs have also been examined in a range of studies using a variety of approaches to learning, technological application and research foci (eg, Scama and Clements, 2002; Wood *et al,* 1999).

2.2 What factors are important for ICT and attainment?

ImpaCT2, strand 3 (Comber *et al*, 2002), and Venezky (2002) identify a range of factors that are important for understanding how ICT has an impact on attainment. They may be summarised as the:

- attitudes of teachers and learners to ICT
- teaching and learning processes which use ICT
- organisation and management of ICT.

2.2.1 Attitudes to ICT

Over nearly two decades, teachers' attitudes, beliefs and practices relating to ICT and learning have been closely examined as the technology has become a stable part of educational settings (eg, Cox *et al*, 1999; Passey and Samways, 1997). These studies point to a number of factors, including the processes of change, school contexts, and training, as being significant in shaping teachers' approaches to the integration of ICT into pedagogical activity.

Teachers develop connected sets of beliefs about subject knowledge, teaching, learning and education through processes of socialisation including their schooling, training and professional practice. (Stevenson and Hassell, 1994). Introducing ICT into teaching and learning can change practices which teachers have developed over a period of time. Studies point to the importance of developing the following:

- *Teachers' personal ICT competence and professional confidence*, and their need for time to appropriate the new technology and use it effectively in pedagogy; this is not a quick process, and may take up to four or five years depending on the context and availability of technology (MacKinsey, 1997).
- *Teachers' ownership of ICT* and its 'fit' with their beliefs and practices. This has a direct connection with teachers' confidence as professionals, and their ability to use ICT effectively for teaching and learning.
- *Professional development programmes* to help teachers integrate ICT into their practices. There have been a number of training initiatives over the past 20 years (Somekh, 2000), with the most recent and ambitious being the New Opportunities Fund initiative (TTA, 2002). Although these have had different outcomes, they have served to raise awareness and provide support for the horizontal integration of ICT into teaching and learning (Ofsted, 2002). Connected with this is the extent to which departments and schools have taken on the training as part of the normal continuing professional development programmes (*Ibid*). This enables a variety of support processes to be developed, which provide the means for teachers to mentor one another.
- *Teachers' personal access* to a computer for the purpose of preparation and planning (*Ibid*).

From an organisational point of view, teachers have the greatest influence in the practical integration of ICT into teaching and learning, and so their attitudes and practices have an important influence on learners' levels of attainment.

Learners' attitudes and experience must also be taken into account. ImpaCT2, strand 3 (Comber *et al*, 2002), has played a major role in helping us understand children's attitudes to technology in learning. It also shows the wide range of sources of children's ICT experience and skills. Clearly, to assess how ICT has an impact on learners' attainment, it is important to take into account this prior experience and level of skills.

The set of measures developed to monitor the role of ICT in attainment must, therefore, take the experience and confidence in the use of ICT of both teachers and learners into account.

2.2.2 Teaching and learning with ICT

ImpaCT2 (Comber *et al*, 2002, Sections 4 and 5) shows that a key issue in establishing connections between ICT and attainment is the nature and extent of ICT use for teaching and learning. This includes the:

- *extent to which ICT is integrated* routinely and appropriately into teaching and learning activities, and the nature of the tasks that learners are given
- *structure of these activities*, and the role and use of ICT within the activities; ICT-based activity is potentially more complex than other kinds of teaching and learning situations, precisely because of the addition of the technology
- *control of the activity* during its different phases, the uses that ICT resources are put to at different stages during the activity, and the characteristics of the person who initiates and structures the dialogue within the activity.

2.2.3 Organisation and management of ICT

Factors connected with sites and their management of the ICT activity have been identified by various reports as conditioning the nature and extent of ICT-based pedagogical activity. These include:

- *policies and procedures* for the management of ICT
- *levels of infrastructure*, including number of machines per head at the site, speed of connections to the internet, and numbers of networked machines
- *technical support* and co-ordination
- *physical organisation and distribution* of ICT resources
- *levels of staff training* in the use of ICT in teaching and learning
- *having a shared vision of ICT*, as part of whole-school approaches to planning
- *strong leadership*, reflected in the range and distribution of ICT resources, and personnel, including co-ordinators and the level of technical support (Comber *et al*, 2002; Becta, 2003).

2.3 Assembling a framework of factors

In making teaching and learning the main focus of this study, a framework was developed that brought together the various factors outlined in the previous section. The framework reflects the view that ICT's potential for affecting attainment has to be understood within the context of the associated activity. It works on the assumption that in order to understand how learners use tools such as ICT, one has to take into account the context of the ICT use and the intentions of those taking part.

For example, focusing just on the use of computers or a whiteboard for teaching and learning misses several important factors. First there is the teachers' intentions for the overall activity and how he/she organises the ICT and the learners to achieve the activity's outcomes. In turn this depends on whether the necessary ICT facilities are available within an institution, and whether learners are ready in terms of skills and knowledge for the activity. (See Appendix 1 for our theoretical approach based on Activity Theory.)

2.3.1 Structure of teaching and learning

Teaching and learning events are not random. Every teaching and learning activity has a set of outcomes which are realised through a characteristic sequence of actions and shape the choice of available resources.

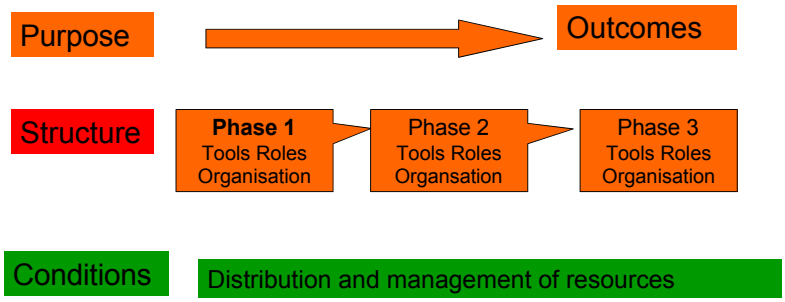


Figure 3: Modelling teaching and learning

Figure 3 shows how these three key dimensions of teaching and learning are connected. The desired outcomes of an activity shape its sequencing over time. The figure shows a three-phase structure corresponding to a “normal” teaching and learning activity with an introduction, main body and conclusion. However, other sequences with just one or two phases are also possible and do occur in practice.

The 'conditions' dimension of this model identifies the physical distribution of computers, whiteboards and other technology, which contributes to helping the activity achieve its outcomes. Establishing the right kind of conditions for ICT to have an effect on attainment is a significant part of a school's management process (Lewin *et al*., 2000b; Passey, 2002; Ofsted, 2002; Becta, 2003). This can be seen through the:

- publication of ICT policy documents for the school and various departments or sections of the school
- co-ordination of ICT across subjects
- distribution of ICT resources according to a school's teaching and learning plan
- training of staff in the appropriate use of ICT
- technical support offered.

2.3.2 Modelling the context of ICT activities

Figure 3 illustrates how an activity develops over time and the factors that enable it to happen. It also shows how each phase of the activity has its own internal structure in terms of tools, organisation and roles. In the case of an ICT activity, the tools are the ICT equipment used, while the organisation includes the structure of the lesson in terms of whether learners are working individually or in groups. The roles within an ICT activity describe the ways in which leaders and learners relate to each other, and whether the lesson is leader centred or learner centred.

The study’s approach was to start with learners' use of technology, and is based on the triangular relationship shown in Figure 4.

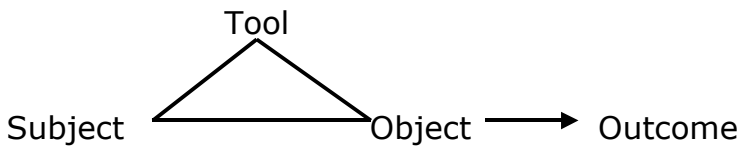


Figure 4: An individual's use of an ICT tool to achieve an outcome.

It shows how individuals (Subject) work with a technological tool on a problem (Object) to obtain a specific outcome. This may be a learner working on a computer-based task or a teacher using a whiteboard or a simulation to illustrate or demonstrate some aspect of a topic.

In practice this use of an ICT tool takes place in a context, usually classrooms with other learners, and activities have to be carefully organised to achieve their goals. The approach taken in the study was to divide teaching and learning activities into phases which show:

- how they develop over time
- the roles, relationships and ICT organisation within each phase.

The sequencing and overall structure of phases are aspects of the way in which an activity is organised to achieves its desired outcomes. Each phase of an activity is shaped by the relationships between leaders and learners and the roles that they play, together with the ICT tools which they share and use.

'Invisible' factors also play an important role in the practicalities of teaching and learning. These include policy decisions by management about the role of ICT within teaching and learning, the practical distribution of ICT resources, the requirements of the curriculum, and agreed schemes of work. Together these make up the 'conditions' dimension of the model in Figure 3, and play an important part in shaping how activities develop and achieve their intended outcomes (see Appendix 1 for a detailed account of the study's approach).

Describing the organisation, roles for teachers and learners, and ICT usage in the various phases is a complex task, since there are many ways of classifying their interrelationships. In the next sections, these factors are described in more detail. Three sets of statements, used for the OECD/CERI case study analysis (1999), were employed to describe the organisation, roles and ICT usage in teaching and learning activities in this study. The sets of statements are described in the following sections. The term 'leader' is used in these statements instead of 'teacher' since some of the settings used in the study were not formal classrooms.

2.3.3 Organisation of teaching and learning

The statements in this category describe how the participants are behaving and who is directing each phase. The scenarios covered include:

- leaders' lecturing/explanation
- leaders' teamwork
- learners' teamwork
- learners' working individually
- learners' reporting or presenting own material.

2.3.4 Roles adopted by leaders and learners

This focuses on who directs the conversation in each phase of the activity. The range of roles includes:

- leader giving information
- leader directing questions and answers to reproduce facts
- leader directing conversation
- leader stimulating reflections or other critical analysis
- learners directing conversation with peers or teacher.

The list shows statements representing a spectrum of roles ranging from the leader talking while the learners listen, through to the situation where leaders are working with the whole class or smaller groups in a less formal manner. The teacher or leader can adopt a tutoring role in these situations (Chi, 1996). Finally, at the other end of the spectrum is a situation in which the learner is controlling the conversation. The latter roles have been identified as

being particularly important in ICT work for developing learners' understanding (Hoyles and Sutherland, 1989).

2.3.5 ICT usage

This identifies who is controlling the ICT resources during an activity. The range of possibilities includes:

- leader using ICT
- learners using ICT individually, initiated by the leader
- learners using ICT in collaborative tasks initiated by the leader
- learners using ICT individually, initiated by themselves
- learners using ICT in collaborative tasks initiated by themselves
- learners interacting via ICT, initiated by the leader
- learners interacting via ICT, initiated by themselves
- learners creating using ICT (visual arts, music, etc).

Starting with leaders as the sole users of technology, the statements range through to the learners being the sole users. The statements also contain indications of who is controlling the technology in the interactions.

2.3.6 ICT Infrastructure

The physical distribution, nature, and number of ICT resources are significant factors in implementing ICT, and hence play a role in learners' attainment. 'Reliable, powerful and efficient' infrastructure is important for enabling the successful implementation of ICT. (Venezky, 2002, p. 25). In particular, infrastructure may have to reach a 'critical level', before the other factors can operate. The DfES survey of ICT in schools found that over 99 per cent of schools were connected to the internet, and 85 per cent of teachers felt confident to use ICT within the curriculum (DfES, 2003). The average number of computers per primary and secondary school were 28.6 and 192.7 respectively, with 7.9 and 5.4 pupils per computer. (*ibid*). ImpaCT2 (Comber *et al*, 2002, Section 5.3 and 6.2) notes that a wide range of configurations are used in primary and secondary schools, including the following, which were used in the present study:

- single computers
- groups of two to five computers
- suites of six to 12 computers
- rooms with more than 12 computers.

2.4 A framework of measures

The model presented in Figure 3 provides a framework within which to develop measures of attainment for ICT-based pedagogy. It suggests three kinds of measure, corresponding to the three dimensions of outcomes, sequencing and conditions. These dimensions are not a hierarchy, but describe how the material conditions and structure of an activity interact dynamically to shape its outcomes.

Table 1 shows the dimensions and the types of measure that are required for each.

Dimension	Focus	Measures
Intention and outcomes	Intention of the activity and its expected outcomes for learners. Related to questions about the nature of attainment and knowledge in the context	Extent to which the activity achieved its expected outcomes, as a measure of the activity's potential for

	of ICT.	improving attainment.
Structure and sequence	Sequencing and structure of phases, described by: • number of phases • organisation and control of phases • roles adopted by participants • use of ICT	Extent of the leader's and the learners' competence and confidence with ICT in teaching and learning. Extent to which the structure of the activity aided its overall aim(s).
Conditions	Physical and managerial factors that condition the activity.	Extent to which the following enabled the outcomes to be achieved: • Distribution of resources • Staff training • Levels of support • Management policy

Table 1: Potential measures of the relationship between ICT and attainment, with a focus on teaching and learning

In the following chapters, we will describe how our approach to collecting and analysing data enabled us to create a set of measures that relate to each of the model's dimensions. Chapter 3 describes the methodology for the study, and Chapter 4 provides the framework of measures that was produced.

Chapter 3: Methodology for the study

This chapter describes the method adopted by the project in collecting and analysing data to develop the framework of measures, including the:

- overall strategy chosen for the study, and the rationale for the way in which the data was collected and analysed
- implementation of the methodology.

3.1 Strategy for the study

To analyse the range of possible factors and the kinds of relationships between the different dimensions of the model, it was decided to:

- collect data about a range of teaching and learning activities across a range of sites
- build and use a relational database to organise and analyse the data collected. Relational databases can be used to summarise data about different dimensions in the model, and to construct relationships between the dimensions, which can be used to examine possible sets of indicative measures (see Appendix 2 for more details).

The overall strategy for the study is described in Figure 5, showing its two tracks: data collection and analysis. Track 1 consisted of the collection of data from observed teaching and learning situations, and the construction of a database to store that data. Track 2 was the systematic analysis of the data to investigate the factors which were relevant to the development of learners' attainment in the context of ICT. Figure 5 also shows the connections between the two tracks.

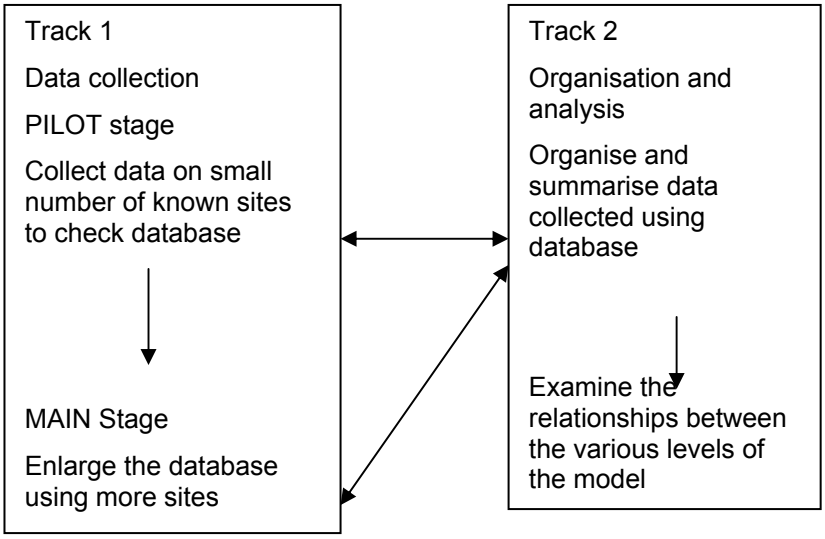


Figure 5: Twin Tracks of the study and their connections

The database was constructed from a body of data that was collected in two stages as Track 1 in Figure 5 shows. The database was then used to examine the relationships between different levels of the model, shown in Track 2.

3.1.1 Track 1: data collection

Track 1 of the study was split into two stages:

- *Pilot Stage*

  The aim was to validate the database and its operation using a limited range of places of education that had known characteristics in relation to the integration of ICT into teaching and learning. This involved examining how appropriate the model was to actual practices, and checking the usability of the database through a detailed analysis of its structure and data types, as they were used in practice.

- *Main Stage*

  The aim was to enlarge the database and include a wider range of new educational sites. The intention was to generate a variety of relationships between the dimensions, using a larger data set, to identify and validate possible collections of significant factors that could form the basis for 'snapshot measures'. This process was both dynamic and iterative as, on the one hand, the data set was progressively enlarged, and, on the other, sets of factors emerged as significant in relation to attainment.

3.1.2 Types of data collected

To obtain data relevant to each dimension of the model described in Chapter 2, it was necessary to:

- *interview activity leaders* about the kinds of attainment, planned or otherwise, that occurred as they engaged in ICT-based activities
- *observe activities*, taking account of their sequencing, organisation, and the roles adopted by teachers and learners as they used ICT
- *collect background information* about sites and participants in the activities.

3.1.3 Process for collecting data

Observations and discussions at each site had the same three-part structure:

- *Meeting before the ICT activity*. An observer from the project team and the leader of the activity discussed the purpose and intended outcomes of the activity (in terms of knowledge, skills and understanding), together with its organisation and resourcing. Together, they agreed which areas of attainment were the focus of the session, and completed a questionnaire about the activity. The observer also completed profiles of the leaders and learners involved in the activity. Data about the educational site was collected before the activities by means of a questionnaire.
- *Observation of the ICT activity*. Using an observation schedule during the session, the observer documented leader-learner interactions, phases of the activity, and the way that ICT was used.
- *Evaluation of the activity*. The observer and the leader of the ICT session compared their notes and observations of the session. They focused on the extent to which the session had met its outcomes, and, together, they collected evidence of learners' attainment to illustrate the points made. They reached an agreement on the potential of the activity for improving learners' attainments with ICT. Three types of attainment were recorded for each activity: 'curriculum', 'ICT' and 'personal'. Personal attainment included judgements about self-confidence, motivation, working with others and autonomous activity.

Each type of attainment was judged using the same set of responses, rated from 1 to 6, as shown in Table 2.

Rating of attainment	Description of the rating
1	All students achieved substantial improvement
2	All students achieved significant improvement
3	All students achieved some improvement
4	Most students achieved substantial improvement
5	Most students achieved significant improvement
6	Most students achieved some improvement

Table 2: Ratings for attainment during activities

The statements were agreed by the project team as reflecting a range of possible attainment, and as being practical to use within the limited time available. There was discussion about how to resolve differences of opinion between leaders and observers, but in practice it was not necessary to do this. Observers were able to comment in free text if an activity did not achieve any of its intended outcomes, but this situation did not occur.

3.2 Implementing the strategy

Leeds (and surrounding districts) is recognised by Ofsted as an 'average' LEA having a wide range of social classes, economic activities, ethnic diversity and cultural backgrounds (http://www.ofsted.gov.uk/reports/index.cfm?fuseaction=lea&id=383&bar=yes). In both parts of the study, sites were identified from the Leeds School Partnership by recommendation as places known to have a range of ICT activities taking place routinely. Two experienced observers were recruited to make the site visits. Both had considerable experience in the observation of ICT-based classes and teachers' professional development.

3.3.1 Pilot Stage site visits

The visits took place between 27 January and 14 February 2003. Eight sites were identified (five primary and three secondary schools), but only seven were visited since one secondary school withdrew at the last minute because of staff shortages. Twenty-two activities were observed across all key stages, and the corresponding information about the site, leaders and learners was collected. A range of attainments was discussed by the observers and the activity leader during the observations. These included the contribution of the activity to the development of ICT skills, curriculum knowledge and the personal development of learners. Data collection and database entry methods were also refined in collaboration with the two observers.

3.3.2 Outcomes of Pilot Stage visits

The database was considered by the observers to be usable for the process of data collection. A balance was struck between predetermined entries in the database fields and free text for the observer. The fields were intelligible to the observers and reflected their understanding of the situations that they were observing. The database was considered to be appropriate for the aims of the project since it enabled the observer to develop profiles for sites, activities, leaders and groups of learners, and record the professional judgements about attainment that were made for the activities. There were no obvious mismatches between the database's fields and the data that it was intended to capture. Data collection methods were both manageable and relevant, and appropriate data collection forms were developed to support the observers in this process. The definition of attainment used by the study was refined by the project team to discriminate more carefully between curricular, ICT and personal outcomes, based on the agreed professional judgements of both the activity leaders and observers.

3.3.3 Main Stage site visits

In light of the experience in the pilot stage, the process for the selection of sites was modified. A collection of sites was recommended through consultation with the Leeds Schools Partnership and Leeds City Learning. Ofsted reports for the recommended sites were then collected, and the sites classified according to location, size and type (eg primary, comprehensive), and by the levels of English as a second language support (E2L), and the number entitled to free school meals. A selection of sites was then made to ensure that the sample was balanced for these factors. A total of 20 sites were chosen, made up of eight primary schools, 10 secondary schools, one special school, and one city learning centre. This process took some time and meant that contacting sites took longer than anticipated.

Visits took place between 3 March and 11 April 2003. Seventeen sites were visited, with three cancelling at short notice. A total of 39 activities were observed across all key stages and details entered into the database.

3.3.4 Track 2: Analysing the data

The second track of the study was systematically to analyse the relationships between attainment and activities, sites, leaders and learners. Two questions were investigated:

- For all of the observed activities, what were the characteristics of the activities, leaders, learners and sites?
- For each activity that was judged to have achieved its intended outcomes, what were the characteristics of the activity, site, leaders and learners?

In trying to answer these two questions, the intention was to look for relationships that could form the basis for a possible set of measures within the model.

First, the database was examined to find any common characteristics. The intention in this first approach was to get a feel for the complex data set that the observations had generated, to summarise the available data, and enable it to be used in the second set of analysis related to attainment. Detailed summaries can be found in Appendix 3.

The second question concerned the relationship between attainment and the use of ICT. The strategy adopted had two stages which started with vignettes of activities (short qualitative descriptions) to explore the range of issues associated with different types and levels of attainment. These were then used to guide the construction of measures related to the three different dimensions of the model. These are presented in Appendix 4.

From these vignettes, factors that seem significant for attainment include:

- the appropriate integration of ICT into the activity through careful prior preparation of skills and selection of resources
- a switch from leader-centred to learner-centred approaches in teaching and learning
- a range of settings from single machines through to rooms with more than 12 machines being used, which provide varying degrees of flexibility to meet the requirements of the chosen activity.

The next chapter outlines how, using these vignettes for guidance, a range of measures were identified and used to examine the potential for raising attainment using ICT.

Chapter 4: Developing a framework of measures

The overall aim was to link the dimensions of our model to aspects of learners' attainment. This would give a sense of an activity's potential for developing learners' knowledge, skills and understanding, as well as for developing personal factors. This chapter presents our analysis of attainment, and the factors that could be used as measures of potential for attainment. The analysis consists of:

- an investigation of the different types of attainment and their connections with each other, which relates to the 'purpose' and 'outcomes' dimension of our model
- two measures for the 'structure' dimension of the model, which relate *leaders' confidence* in using ICT to the *type of teaching and learning* that took place
- a measure of the *potential for attainment* with ICT using the full model which connects its three dimensions of outcomes, structure and the practical conditions for the activity.

4.1 Activity outcomes and attainment

In this study, three types of attainment were recorded for each activity: 'curriculum', 'ICT' and 'personal'. Personal attainment consisted of judgements about self-confidence, motivation, working with others and autonomous activity. Using the attainment ratings described in Table 2, the range of different outcomes for each type of attainment was described, together with their relationships to one other.

Attainment was rated according to the extent to which an activity was judged to have met its objectives by its leader and the project observer. This was used as a measure of an activity's potential for developing learners' attainment.

Four different types of hardware configuration were used in the activities. These were categorised as:

- single machines
- groups (two – five machines)
- suites (six – 12 machines)
- rooms (over 12 machines).

All the observed activities were distributed fairly evenly across all the configurations, and no direct connection between the resources and any of the attainment types was found, although hardware configuration remained an important factor.

Each activity was rated for the extent to which it met its desired curricular, ICT skills or personal outcomes. Some activities had all three types of attainment, while others had either curricular or ICT skills attainment combined with personal factors, depending on their focus.

4.1.1 Curricular attainment

The curricular rating indicated the potential of the activity for developing learners' attainment, by expressing the extent to which it met its intended curricular outcomes. Table 3 shows the distribution of these attainments for this category. One activity, which was an introduction to control, was classified as a curricular activity but did not use any ICT resources.

Attainment rating	1	2	3	4	5	6
No. of activities assigned to each attainment rating	9	7	6	8	6	4

Table 3: Distribution of curricular attainment for the observed activities

The distribution is fairly even with only four out of the 40 activities being assigned the lowest rating of 6, described as 'Most students achieved some improvement'.

Relating curricular attainment to personal factors gives:

- a positive association between self-confidence and collaboration (Spearman's Rank Coefficient at five per cent was used for all correlation checks)
- no association with either motivation or autonomy.

This latter result may be due in part to the directed nature of curricular attainment in which the learner does not necessarily choose what to learn or how to learn it. However, working with ICT may enable learners to collaborate more and develop their self-confidence, since it enables them to exchange and find solutions to problems.

4.1.3 ICT skills attainment

This type of attainment refers to those activities which were intended to develop ICT skills. Table 4 shows the distribution of the ICT attainment and the extent to which the activities met their learning outcomes.

Attainment rating	**1**	**2**	**3**	**4**	**5**	**6**
No. of activities assigned each attainment rating	7	10	4	5	3	5

Table 4: Distribution of ICT skills attainment for the observed activities

There is an uneven spread of these attainment ratings, with approximately 30 per cent of the activities given a relatively high rating of 2, as 'All students achieve significant attainment'.

The majority of these activities took place in rooms (more than 12 machines). Given that these activities are concerned with skill development, it is to be expected that rooms providing learners with individual access or pair working should be common.

Relating ICT attainment ratings to personal factors gives:

- significant associations with self-confidence and motivation
- no significant associations with autonomy and collaboration.

This latter result may be due to the heavy task focus in ICT-skill development, in which learners have specific things that they must achieve. From a personal point of view this can be both motivating and build self-confidence, but can reduce the opportunity for learners to collaborate with others or work on their own projects.

4.1.4 Personal attainment

The breakdown of personal attainment ratings is shown in Table 5.

Attainment rating	**1**	**2**	**3**	**4**	**5**	**6**	**Total no. of activities**
Self confidence	10	7	8	12	9	5	51
Motivation	14	7	9	12	6	8	56
Collaboration	5	8	1	4	8	10	36
Autonomy	3	6	4	8	6	10	37

Table 5: Number of activities assigned to each attainment rating for the personal factors

A number of interesting points arise from the Table 5:

- Motivation had the highest number of activities which were rated at one ('All students achieved substantial improvement').
- 'Collaboration' and 'autonomy' both have more activities rated as six ('Most students achieved some improvement') than rated at another attainment level.

- 'Self confidence' and 'motivation' have breakdowns that are similar, with the highest number of activities occurring in the same ratings of 1 and 4. These seem to be definite 'peaks' in their respective breakdowns.

There were a number of significant associations between the four personal factors of motivation, self-confidence, autonomy and collaboration. ICT has the potential for developing a range of personal factors. It gives the opportunity for learners to relate to both tasks and to each other in a variety of ways, and hence to enhance their personal development. In particular, ICT-based activities showed that the attainment ratings of:

- motivation and self-confidence were both associated significantly with autonomy and collaboration
- collaboration and autonomy were not significantly associated with each other.

Common sense suggests that these latter two are not related, and may not develop together in the same tasks.

4.2 Structure and sequencing of activities

This section outlines the measures associated with the second dimension of the model, 'structure', referring to the processes of teaching and learning and their participants.

4.2.1 Leaders' confidence with ICT

Leaders' confidence measures in using ICT were obtained by combining information drawn from each leader's profile. Appendix 5 contains details of how these scores were obtained from the leaders' profiles.

Three main groups of leaders emerged from this measure:

- *Leaders' confidence group A* represents those leaders with a long experience of teaching, but who made comparatively little use of ICT for teaching or administration. Eleven per cent of the leaders were placed in this group.
- *Leaders' confidence group B* represents those with a long teaching experience, but shorter, albeit extensive, experience with ICT. Forty-seven per cent of leaders were judged to be in this group.
- *Leaders' confidence group C* consists mainly of leaders who had used ICT for all of their relatively short teaching career. Forty-two per cent of the leaders fell into this category.

The difference between group B and group C leaders can be illustrated by comparing two successful leaders at the same site. One leader, in group B, had been teaching for three years, and was the ICT co-ordinator. This leader was observed in a mathematics activity in which ICT was used in a routine way as part of an activity, and who seemed to be at ease with the role that the ICT played. Learners were judged as having made significant improvement in the activity. The other leader, in group C, had only used ICT for four of that leader's 28 years as a teacher, and was observed in an activity which was an introduction to programming with a year 2 group. The activity was judged as enabling all learners to make significant improvement in both the development of ICT knowledge and skills and personal qualities. The lack of ICT experience seemed to be compensated for by a long experience of teaching, although the leader expressed nervousness about using ICT.

We concluded that groups B and C should form part of the measure for the 'structure' dimension of the model, since the leaders were primarily responsible for organising this aspect.

4.2.2 Structure of teaching and learning

Each activity was divided into up to one, two or three phases (usually described as 'lesson introduction', 'main body' and 'conclusion' in a ‘normal’ activity). For each phase, the observer noted how it was organised, which roles the leaders and learners undertook, and who was using the ICT resources. Table 6 shows the percentage of the activities with one, two or three phases:

Activities with phase 1 (%)	Activities with phase 2 (%)	Activities with phase 3 (%)
100	91	65

Table 6: Percentage of the activities with one, two or three phases

The majority of the activities had at least two phases, with 65 per cent having three. This meant that all the activities had both an introductory and a development section, with some having a clear conclusion.

We found three basic teaching and learning structures used in the various phases:

- *No structure*: There was no discernible teaching and learning structure using the project categorisation.
- *Leader-centred*: The activity leader introduced the task using the ICT, and asked learners questions to check facts or to confirm that they had understood what they had to do.
- *Learner-centred*: The leader made learners the focus of the activity, with learners using the ICT. Learners were directing the conversation as they worked on the task that they were set or chose, and leaders asked questions to encourage critical reflection or to confirm understanding.

Table 7 contains a breakdown of how these three approaches to teaching and learning were spread across the phases of the activities.

	Phase 1	Phase 2	Phase 3
No teaching structure	0	8%	27%
Leader centred	80%	10%	15%
Learner centred	20%	82%	58%

Table 7: Breakdown of the teaching and learning structure, and their distribution across the phases of the activities

Phase 2 activities:

- were learner-centred in 82 per cent of the cases where it was found
- occurred in 91 per cent of all activities.

It was decided that Phase 2 structure should be included in the measures, since it was the main time in an activity when learners had the opportunity to use ICT.

4.3 The framework of measures

On the basis of these analyses, a model was developed that brought together all three dimensions of the framework. This consisted of:

- A 'Potential for attainment' score, obtained from the various types of attainment.
- The Teaching and learning structure, organised by leaders' confidence categories (A, B or C) and the structure of phase 2 (leader-centred or learner-centred).
- The Organisation of hardware: single, group (two – five machines), suite (six – 12 machines) or room (more than 12 machines), since this is fixed by the site in which the activity happens.

For each type of hardware organisation, and also for a combination of the leader confidence score and phase 2 structure, we calculated the 'potential for attainment' score. The full details of this score and its breakdown using the model are in Appendix 6.

4.4 Outcomes of the analysis

We found that activities scoring the highest 'potential for attainment' scores across all four hardware configurations (single, group, suite and room) and all three types of attainment had very similar characteristics.

- *Teaching and learning structure*: All the activities had at least two phases which started with a leader-centred approach and then switched to a learner-centred activity.
- *Leaders' confidence with ICT*: Three-quarters of the activities were led by members of leader group B (those with considerable experience in teaching, but who have used ICT for a comparatively shorter period).

Chapter 5: Findings and recommendations

This chapter summarises the findings of the study and makes recommendations for further work.

5.1 A set of measures of the potential for developing attainment using ICT

On the basis of the analysis in Chapter 4, we propose the following set of measures which indicate the potential of activities to improve attainment using ICT:

- A measure of the extent to which an activity achieves its outcomes, taking into account the preparations made by the leader.
- A measure of an activity leaders' confidence and competence in using ICT for teaching and learning.
- A measure of the structure of teaching and learning activities, which indicates the extent to which leaders enabled learner-centred behaviour using ICT.
- A measure indicating the potential for attainment with ICT. Each activity was placed in one of 24 categories according to its:
  - hardware configuration
  - leaders' confidence score
  - phase 2 teaching and learning structure.

  A 'potential for attainment' measure was then obtained by multiplying the average attainment rating for each category by the relative frequency with which each category occurred in the sample of activities.

5.2 A Model of teaching and learning with ICT

We found that the activities with the greatest potential for developing attainment were those:

- that had clear outcomes and were carefully planned, using ICT appropriately
- where learners had the necessary ICT skills for the activity
- where learners had the opportunity for sustained work using ICT, either on their own or with other learners
- where leaders were skilled in engaging learners in reflection and analysing their own work with ICT, both informally and with whole groups.

5.3 Recommendations for further work

Every effort was made within the timeframe of the study to obtain as representative a sample as possible. Enlarging the sample and period of data collection would enable us to:

- *Check the measures for validity and reliability*, since they are derived from the data collected.
- *Check the validity of the judgements made by those who observed the activities*. This could be done in a variety of ways, including with the use of videos. Observers would view a video of an activity, making their assessments separately, before comparing their judgements. The ensuing discussion would add to the validity and reliability of this important measure. Time constraints, and the recent introduction of the requirement that all learners have to give permission for videoing to take place, meant that this check could not be made. However, given the experience of the observers involved in the project, we do not believe that the lack of this check invalidates the results that we have presented.
- *Analyse individual learner's attainment related to the various activities that they have participated in, using a value-added analysis of their curricular, ICT and personal attainment over a period*. This longitudinal study would compare individuals' progress

over a period, as measured through routine assessment activities, against baselines such as cognitive ability or verbal reasoning tests. We expect this to give more information about the relative value of processes involved with ICT-based teaching and learning, rather than just the outcomes in high-stakes assessments. A useful approach would be to use techniques similar to those in ImpaCT2, strand 3 (Comber *et al*, 2002), to ascertain learners' views of their own progress.

- *Examine in greater detail the relevance of the single-machine category to the question of ICT's role in attainment*. Although it scores highly in the various ratings, it is not clear whether the single-machine configuration is appropriate in a study of ICT's contribution to developing attainment. Apart from when a learner is being taught on a one-to-one basis, we wonder whether the measures “merely” show the general quality of teaching and learning. Naturally this is a question that can be raised about other hardware configurations, and we think that this is an issue that merits further investigation.

Appendix 1: Activity Theory and its role in the study

Two keys ideas form Activity Theory were used to model teaching and learning situations and how ICT fits into them:

- Activity structure (Leont'ev, 1978) to capture the structure of teaching and learning activities over time, and how they are shaped by institutional factors.
- Activity system (Engeström, 1987) to describe the detailed relationship between the use of ICT tools, teachers and learners.

Activity structure

Activity Theory identifies three interconnected levels in analysing how activities meet or do not meet their goals. Figure 1 shows that activities are shaped by their purpose, their organisation over time, and the material conditions that can enable or prevent them achieving their purpose.

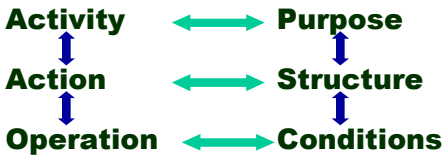


Figure 1: Activity structure

Every teaching and learning activity has a set of intended outcomes which are realised through a characteristic sequence of actions. The ability to perform the actions depends on a number of practical factors such as having suitable tools and resources available at a time and in a way that enables the actions, and hence the activity, to happen.

Activity system

Our approach was to start with learners' use of technology, which is usually thought of in terms of the triangular relationship shown in Figure 2.

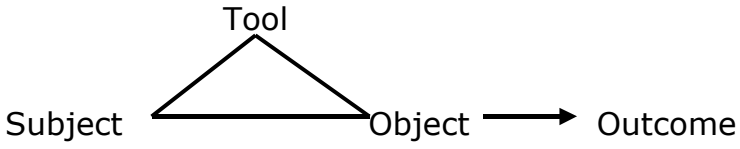


Figure 2: Individual's use of an ICT tool to achieve an outcome.

It shows how individuals (Subject) work with a technological tool (Tool) on a problem (Object) to obtain a specific outcome. This may be a learner working on a computer-based task or a teacher using a whiteboard or a simulation to illustrate or demonstrate some aspect of a topic.

In practice this use of an ICT tool takes place in a context, usually classrooms with other learners, and activities have to be carefully organised to achieve their goals. Activity systems set this relationship in a context which highlights how physical, organisational and cultural factors shape what is happening. Figure 3 indicates a second layer to the triangle which shows how the factors are related.

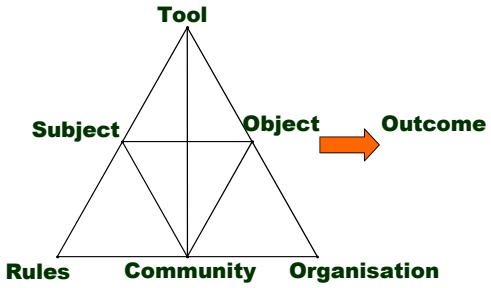


Figure 3: Activity system

Teaching and learning situations contain leaders and learners who together engage in activities that are governed by policies and resource distribution (rules), shared values and practices (community), and forms of management (organisation).

Together the activity system and structure give the model shown in Figure 4, which was used in the study.

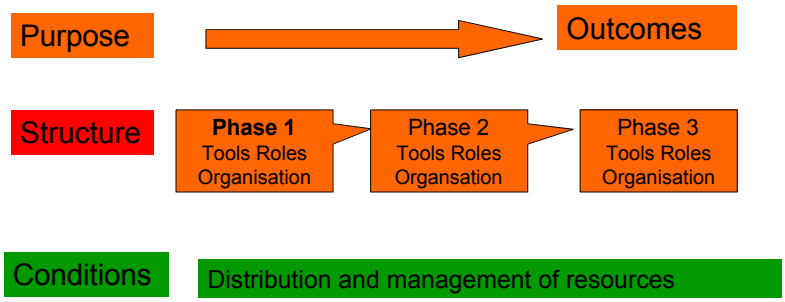


Figure 4: Model showing the structure of ICT-based activities

The approach taken in the study was to divide teaching and learning activities into phases which show:

- how the activity develop over time
- the roles, relationships and ICT organisation within each phase.

The sequencing and overall structure of phases are aspects of the way in which an activity is organised to achieve its desired outcomes. Using the Activity System idea, each phase of an activity is shaped by the relationships between leaders and learners and the roles that they play, together with the ICT tools which they share and use. 'Invisible' factors also play an important role in the practicalities of teaching and learning. These include policy decisions by management about the role of ICT within teaching and learning, the practical distribution of ICT resources, the requirements of the curriculum, and agreed schemes of work. Together they make up the 'conditions' dimension of the model in Figure 4, and play an important part in shaping how activities develop and achieve their intended outcomes.

Appendix 2: Relational databases and their use in the study

Relational databases enable data to be:

- organised into independent logical units that can be analysed separately for common characteristics
- systematically related to examine connections between the logical units.

The database used in the study was constructed from data that was collected in the Pilot stage of track 1 and enlarged in the Main Stage. It was then used to examine relationships between levels of the model.

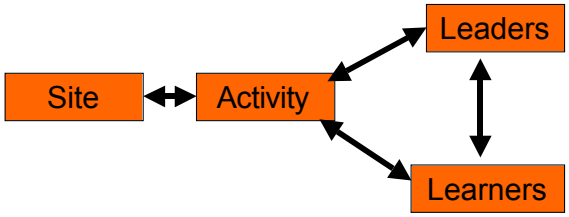


Figure 1: Structure of the relational database used in the study

Figure 1 shows the basic structure of the database, made up of four independent entities – activity, leader, learner and site – that reflect the study's focus on activities and the context in which they occur. These were chosen to match the elements of the model described in Appendix 1. Possible sets of relationships between the different levels of the model were then investigated.

Activity entity

The 'activity' entity was the central focus of data collection. It was used to organise data about the purpose, structure, process and outcomes of ICT-based activities. Four aspects formed the core of this entity, related to each level of the model. They were the:

- purpose of the activity, including its outcomes and relevant prerequisites (this relates to the 'outcomes' dimension of the model)
- structure of the activity, divided into phases, with the associated roles, organisation and ICT-usage adopted by the participants (this relates to the 'structure' dimension of the model).
- tools and tasks used in the activity, including presentation, communication, software and distribution of ICT resources; the range of software and hardware options draws on the Becta list (2000) and Comber *et al* (2002).
- assessment of the activity, containing judgements about the extent to which the activity met its outcomes, and any changes that the leader of the activity wants to make. This is connected with the 'purpose' dimension of the model, and forms the central judgement made at that level.

Leader entity

This entity organised information connected with the 'structure' dimension of the model, since leaders play a significant factor in directing and organising teaching and learning activities. There are two aspects to this entity:

- Professional background, including the leader's type of degree, teaching qualifications and years as a teacher.
- ICT experience, including number of years of experience, New Opportunities Fund (NOF) training, type and frequency of usage, and access to technology outside formal educational settings.

Learner entity

This entity collects the information connected with same ‘structure’ dimension of the model, about groups of learners that participated in activities. There are two aspects to this entity:

- ICT experience in terms of software used, time using ICT, and access in formal educational settings.
- Type and frequency of home access.

Site entity

This summarises the factors identified as related to the 'conditions' dimension of the model and to the site of ICT activity. It records the range and distribution of ICT resources, including the level of technical support, internet connectivity and the configuration of hardware. Two types of information were used:

- Site details, describing the type and location of the site.
- ICT resources at the site, including information about connectivity, resource distribution, staff training, and policy approaches to ICT.

Appendix 3: Profiles of sites, activities and their participants

This appendix describes the sample used, including the various sites (Section 1), participants (Sections 2 and 3) and activities (Section 4) used in the study. The intention is to:

- provide a background for the study by summarising the entities used to make up the database
- identify common characteristics or properties of the entities in the database
- indicate possible ways that the data can be used to create the framework of measures.

Profile of the sites

The profile of the sites used in the study is provided under the following headings:

- Background of the sites, containing summary information about type, location, size and socio-economic profile.
- Distribution of ICT resources within the site.
- Management of ICT, as an indication of the site's commitment to ICT.

Background of the sites

Twenty-four sites were used in the study. To ensure that they formed a representative sample, Ofsted reports were consulted to give a range of sites that covered different types, locations, numbers of pupils on roll, numbers of pupils receiving free school meals, and the numbers of pupils receiving support for speaking English as a second language (E2L).

Table 1 shows the types of sites that were used.

Infants	Junior	Primary	Special school	Comprehensive	CTC	Grammar	Specialist School	Informal
1	1	10	1	7	1	1	1	1

CTC – city technology college.

Informal – inner-city after-school drop-in centre for GCSE students.

Table 1: Types of schools used in the study

The sites were in a range of places in and around Leeds. Table 2 shows the categories derived from the descriptions in the Ofsted reports about the various sites.

Locations	Rural	Semi-rural	Suburban	Town	Inner city
Primary	1	1	3	4	5
Secondary	0	1	2	1	6
All	1	2	5	5	11

Table 2: Locations of the sites

To gauge the socio-economic level of the learners at the sites, the average number on the roll and the number receiving free school meals were compared. Table 3 shows the average distributions.

	Number on role	Free school meals
Primary	275	56
Standard deviation	88.5	44.5
Secondary	1300	115

Standard deviation	475	103

Table 3: Average number on role and those eligible for free school meals

There are wide variations in the levels of free school meals, which reflect the diverse socio-economic background of the pupils in Leeds and its surrounding towns and villages.

Finally, the number of pupils who were classified as receiving E2L support is shown in Table 4.

Type	No E2L	Under 20% E2L	Over 20% E2L
Primary	5	6	2
Secondary	6	1	4
All	11	7	6

Table 4: The distribution of E2L support at the sites visited

The percentages were derived from the descriptions in the Ofsted reports.

Distribution of ICT resources

The distribution of ICT resources at sites is usually given in terms of a computer:pupil ratio. In this group, the mean number of pupils per computer was 7.8 (standard deviation=3.6), with primary schools having 9.8 pupils per machine (standard deviation=3.7) and secondary having 5.5 (standard deviation=1.8). These ratios correspond well with the national average at the time of the study of 8.8 pupils per computer (Ofsted, 2002).

However, a wide range of configurations was found across the 24 sites. Table 5 shows the average distribution of the four categories, derived from Ofsted reports (2002).

	Single machine	Group (2–5 machines)	Suite (6–12 machines)	Room (over 12 machines)
Primary	9.9	5.0	1.5	1.0
Secondary	29.3	3.0	2.7	7.7
Total	19.0	3.9	2.3	4.9

Table 5: Average distribution of hardware configurations

As Table 5 shows, higher levels of single machines (including laptops) were found in secondary sites, but the group distribution (2–5 machines) was more common in primary sites. Suites (6–12 machines) were more common in secondary sites, as were rooms with more than 12 machines. This latter configuration was far more likely to be found in secondary sites than primary. There was quite a wide variation of hardware configurations within the primary sites. The modal form of connectivity was 128 Kbps, which occurred mainly at the primary sites, although all sites had high levels of connectivity.

Management of ICT

Following on from the 'conditions' dimension of the model, three factors were examined by the study to give a sense of a site's commitment to the use of ICT:

- The vertical integration of ICT as a separate subject within the curriculum or the horizontal integration of ICT across the curriculum at each site.
- A published site policy for ICT indicating a commitment to ICT.
- The level of completion of New Opportunities Fund (NOF) training. (The NOF ICT training initiative for teachers and librarians was launched in 1999 to provide ICT training for serving teachers and school librarians in maintained schools in the UK.)

In the primary schools, 70 per cent of the sites described their integration of ICT into the curriculum as 'mixed', meaning that they used a combination of separate ICT- and curriculum-focused ICT activities. The remaining 30 per cent described their approach as ICT 'across the curriculum'.

All primary schools had a published ICT policy, and the average NOF completion rate was 84 per cent.

All secondary schools described their approach to integration of ICT as 'mixed', with an average NOF training completion rate of 73 per cent. There was a mixture of responses to the publication of the ICT policy. Fifty per cent of the secondary schools did have a published ICT policy. The remainder of the schools either did not have a published policy or were either a city technology college or a technology college, and did not distinguish ICT as a separate policy category.

Besides the distribution of ICT resources, a number of factors affect the way that ICT is used in teaching and learning. Two important areas are levels of technical support and the co-ordination and management of ICT at a site.

Technical support

An important factor that enables ICT resources to be available is the degree of support provided. Information about technical support was systematically collected at 13 sites, and the categories were:

- Technicians employed by the school.
- Teachers employed at the school that had technical knowledge and who were required to support the network informally. Within the schools visited this type of support was always provided without financial reward and rarely with any time 'off-timetable' provided. Though these conditions make this support difficult to quantify, discussion with ICT co-ordinators in schools suggested that approximately one day per week was spent by some teachers in this way.
- Support from external agencies – normally LEA support staff or as part of a support contract provided by the hardware suppliers.

Interestingly, only the secondary schools visited had any in-house technical support staff. Of the schools without in-house technical support, only two did not have any form of formal support contract. A measure of the level of support for a site might be possible to quantify by considering the appropriateness of these different modes for the teaching and learning needs of the leaders and learners.

Co-ordination and management of ICT

The role of ICT management and policy development was partially explored as part of the project, by collecting data concerning the type of ICT policy and whether or not it was published. All the schools visited stated that their ICT policy was predominantly a mix of cross-curricular and single-subject approaches to the integration of ICT.

The level of management and development of this policy seemed to vary a great deal. At one extreme, several schools seemed to be constantly revisiting and revising their policy, curriculum plans and resource requirements. At the other extreme, a few schools had no published policy and no plans to introduce such a document. Most schools lay between these extremes, perhaps with a policy but no plans to revise it, or maybe with a policy but with stated difficulties with its implementation, monitoring or evaluation.

The roles adopted by the ICT co-ordinators included:

- ICT teacher
- NOF trainer and/or ICT trainer as described above

- cross-curricular ICT manager
- policy developer
- network manager and technician.

The extent to which these roles are divided among those responsible for co-ordinating and managing ICT, and the relative weight that is accorded to how the roles are distributed is significant for ICT-based pedagogy and its resulting impact on attainment. Measures of these resource distribution and management roles, which enable ICT, and hence attainment, may be generated from indicators of technical support and the role(s) relevant to ICT co-ordination and management. However, given the focus of the study on activities across a range of sites, it was not possible to examine the relationship between these management and coordination aspects of a site, and the pedagogical activities that were made possible. This is a topic for further study.

Learners

The learners in the study were treated as a group, since this was the way in which they were encountered in the activities. Information was gathered about their age, prior software experience, time spent in formal settings, and ICT experience at home.

Data from 61 activities was collected. Practical constraints at some sites meant this data could not be collected completely for all groups, and complete learner data was available for fifty-six activities. The following tables show the features of the groups that took part in the activities. First, Table 6 shows the spread of year groups.

N	R	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	3	7	3	6	3	4	7	3	7	1	6	3	1

N – nursery.
R – reception.
1–13 refer to school years.

Table 6: Distribution of year groups used.

Three other activities were recorded, which involved learners from a range of school years, but they are not recorded in Table 6. The first was a vertically grouped activity involving learners from years 3, 4 and 5 in a primary school. Two other activities took place in an informal drop-in centre site for all secondary ages.

Table 7 shows the spread of ICT experience in formal pedagogical activities, as reported by the learners.

Every day	More than three times per week	Three times per week	Twice per week	Once per week	Once a fortnight
5	9	4	9	21	2

Table 7: Learners' experience in formal pedagogical activities

The modal value is once per week, with some groups having ICT experience more than three times per week.

Leaders

Forty-eight activity leaders took part in the study. Information was collected on their academic and professional background, together with their ICT experience in formal settings, and their access to ICT at home. They were referred to as 'leaders' rather than 'teachers', since at some sites there were not formal activities that corresponded to 'lessons', and in some sites activity leaders were not qualified teachers.

Tables 8 and 9 show, respectively, the academic and professional qualifications of the leaders.

BA	BEd	BEng	BSc	Masters	None	Not rec
16	6	2	10	2	1	11

'Not rec' refers to those whose degree was not recorded.

Table 8: Academic background of the leaders

Instructor	Cert Ed	PGCE	QTS	None
1	8	24	13	2

'None' refers to teaching assistants who led ICT activities in two primary schools.

Table 9: Professional qualifications of the leaders

Table 10 shows the distributions of leaders' years in teaching.

Years in teaching	1–10	11–20	21–30	31–40
Number of leaders	32	5	10	1

Table 10: Leaders' years in teaching

Table 11 shows the range of the leaders' experience in using ICT for teaching.

Years using ICT in teaching	1–10	11–20	21–30	31–40
Number of leaders	34	13	1	0

Table 11: Leaders use of ICT in teaching

The majority of leaders have ICT experience of between one and 20 years, although this is made up of two distinct groups. Many leaders had gained ICT experience relatively recently in their comparatively long teaching careers, while other leaders had ICT as an integral part of their initial training and teaching experience.

Training leaders in the use of ICT was a significant factor in the successful and appropriate use of ICT in teaching and learning. This was particularly important given that there were a number of leaders who had used ICT, but had not been formally trained. NOF training was provided as a major national initiative to deal with this question – Table 12 shows the numbers of leaders who had received NOF training.

Not undertaken	Not completed	Completed	NOF trainer
11	6	30	1

'Not undertaken' indicates those who were exempt because of their prior ICT experience.
'Not completed' indicates those who were still completing the training.

Table 12: NOF training of the leaders

Most leaders had received some form of training and had an awareness of the role that ICT could play in learning.

Activities

In total, 61 activities were observed, but two are not reported due to incomplete data. Each activity was classified by the leader and observer according to the task involved. The tasks were either:

- ICT-skills tasks, designed to develop aspects of learners' skills and knowledge of ICT
- integrated tasks, in which learners used ICT to support their attainment in curricular knowledge and understanding. Included in this category were aspects of the ICT curriculum such as programming, database theory and control.

Integrated tasks

Forty-one of the activities were classified under this heading. One activity did not use ICT, but was an introduction to the control aspects of the ICT curriculum and so was classified in this section. The following tables, Tables 13 and 14, summarise the hardware configurations and software used. Table 12 shows the different configurations of computers used for integrated tasks.

Single	Group (2–5)	Suite (6–12)	Room (>12)
15	6	4	15

Table 13: Hardware configuration of the integrated tasks

The most common configurations were rooms or single machines in a variety of locations.

Table 13 shows the software used.

CAD/CAM	CD-ROMs	Content-free	Generic	ILS	Presentation	Programming	Small software	Web browsers
1	2	6	7	2	4	2	8	8

CAD/CAM – computer-aided design/computer-aided manufacture.
ILS – integrated learning system.

Table 14: Software types used during the observed activities (one per activity)

The most common types of software were web browsers and small software used for specific topics including mathematics, English, science and history.

ICT skills activities

Eighteen tasks were classified under this heading. A striking feature of these types of activity was that 17 out of the 18 reported took place in a room with 12 or more machines. The other activity used a single machine to demonstrate features of a paint package to a reception class.

The range of software is shown in Table 15, and suggests that most of the activities were concerned with enabling learners to gain skills with generic and content-free software.

Content free	Generic	Presentation	Small software	Web browsers
5	7	3	1	2

Table 15: Types of software used in the ICT activities

Appendix 4: Case studies of teaching and learning

This chapter presents seven vignettes of activities that were observed, taken from the information that was recorded in the database. The intention is to:

- illustrate the type of activities that were observed across the range of sites, ages, types of hardware and software, and tasks undertaken
- provide a sense of how the various types and levels of attainment were interpreted by the project team
- identify different approaches to teaching and learning with ICT that were adopted by the project's participants.

The descriptions are presented according to different kinds of attainment: curricular, ICT skills or personal. 'Attainment ratings' refers to one of the six descriptions of attainment given in Section 3.1.3. Each vignette lists the year group, site type, topic and ICT resources used, and sets the observed activity in the context of what preceded and what followed it.

The vignettes have been chosen to illustrate different approaches which make central use of ICT. They demonstrate what we considered to be interesting and innovative ways of using technology. Although they may not be as highly rated as others, we felt that they had real potential for developing learners' attainment.

Curricular attainment

Nearly all the activities began with the leader lecturing, explaining and/or questioning the learners, usually using ICT to assist the process. In the second phase of an activity, learners tended to work individually with ICT, and the leader engaged in questioning, either to clarify what the learners were doing or to encourage their critical reflection.

This activity structure is illustrated in the first vignette for an activity judged to have an attainment rating of 3.

Vignette 1: Year 3, primary school

Topic: Writing up a trip to an art gallery.

Resources: Room (more than 12 machines), data projector and content-free software.

The leader introduced the task and held a question-and-answer session on basic keyboarding, asking pupils to check answers by using their computers. In the second part of the activity, learners worked alone or in pairs, typing their draft report with the word processor and occasionally revising as they worked. The leader monitored progress. In preparing for the activity, the learners had received one lesson about the composition and structure of paragraphs, and one lesson on writing the first draft of the composition. One more lesson was needed to finish typing, but other lessons were planned to follow on with use of text effects, and redrafting for presentation.

ICT skills and curricular work are woven together in this activity, with skills being first developed and then used in a meaningful activity. The activity was then used to motivate further development of ICT skills. The ICT knowledge and the curricular tasks were intertwined so that one helps to prepare and enhance the other.

The next vignette, of an activity given an attainment rating of 5, shows another way of integrating ICT into a range of related activities.

Vignette 2: Year 7, special school

Topic: Use of computer software to draw and then print tessellating patterns.

Resources: Group (2–5 machines) using small software.

The leader introduced four tasks that made up a circus of activities related to tessellations, one of which was ICT based. After organising the learners into groups, the second phase began with the learners working on the tasks, using the software to create tessellations. Other

tasks included using plastic stencils and shapes to draw repeating patterns, and working with the teaching assistant in the hall to draw floor patterns. During the final part of the activity, the leader monitored the learners' progress and used a digital camera to take pictures of drawings and tessellations for assessment purposes. Together the leaders and the learners discussed what the learners had found out. In preparing for the activity, the group had seven or eight 40-minute lessons about 2D shapes and names, and simple patterns from around the world. To follow up the activity, the leader had planned one or two lessons to finish off work, with one lesson to review work and refocus on the objectives of the activities to produce a portfolio. One piece of homework was planned on tessellations. In reviewing the activity, the leader felt that four activities were too many, and intended to include three tasks to make monitoring easier.

Using a circus of activities is a useful strategy for linking ICT experience with other approaches, since ICT can be used to maximise its unique contributions to learning. Learners can improve their motor skills using paper and pencil, and the ICT can automate these processes to enable them to reflect on higher-order concepts. Vignette 2 is focused on creating and manipulating tessellations in different ways, and makes use of the software to generate patterns very quickly so that learners can appreciate their overall structure.

The next vignette, although the activity was rated at 6, shows how ICT can play a part in a range of activities that draw on its specific strengths.

Vignette 3: Year 5, primary school

Topic: Create a computer-generated newspaper on the Victorians.

Resources: Suite (6–12 machines) using web browsers and the internet.

The learners' task was to collect information and images to create a computer-generated newspaper on the Victorians. The activity began with a short introduction by the leader, which referred to instructions written on the board. The learners worked independently using information from textbooks and from websites to construct the newspaper. The leader discussed progress with the learners, helping them to reflect on their approach. The activity continued, with no coherent final part to the activity. In preparing for this activity about Queen Victoria and the Victorians, the learners had used an LEA network and a search engine to access websites. They knew how to enter and edit text from websites, and could transfer and manipulate images, although the skills had not been formally prepared before the activity. Given the open-ended nature of the task, there were no specific follow-up activities.

The Year 6 learners were able to combine information from a variety of sources using ICT, without preparation. This highlights the importance of building up a repertoire of ICT skills over a period so that learners can use them appropriately in new activities. Having the opportunity for independent and self-directed activity is a feature of this vignette, where the learners worked for a long period on their own tasks.

ICT attainment

Attainment with ICT can be classified as development of skills and of understanding. Knowing how to select and use ICT tools in particular situations to help achieve specific outcomes is a key ability that enables learning. To understand why ICT is relevant in different situations it is often necessary to know about concepts that appear as part of a curriculum for ICT, understood as an academic discipline.

The following two vignettes, both for activities with an attainment rating of 1 for ICT attainment, show ways in which skills can be developed.

Vignette 4: Reception class, nursery and infants school

Topic: Drawing a house using a drawing program.

Resources: Single machine with generic software.

The leader started by demonstrating the use of tools within the drawing package to a learner. Working together, the leader and learner drew a house. Finally the learner worked individually

to draw a house. Prior to the activity, the learner had several lessons on basic mouse skills, saving and printing. The activity was the culmination of a series which introduced learners to basic skills needed to work with ICT.

Working with a learner on a one-to-one basis, the leader first modelled the desired skills and behaviour, before working collaboratively with the learner. Finally the learner works individually on the task, with the leader monitoring progress.

In the next vignette, also with an attainment rating of 1, the process of skill development is shown at a later stage.

Vignette 5: Year 6, primary school

Topic: Producing multimedia presentations.

Resources: Interactive whiteboard with a single machine and a room of 12 or more machines.

The aim of the activity was to use a multimedia authoring tool to produce presentations to be shown to younger pupils. Prior to this activity, the learners had spent approximately three hours using the software. About one and a half hours had been spent using the program to produce a multimedia presentation, although the learners had used the program as a word processor for a long time. The leader began by explaining the structure of the activity using a multimedia presentation as visual cue. Learners then produced their presentations. During a question-and-answer session after the presentations had been produced, the leader asked learners to think about the skills they had learnt and used up to that point. Learners then collected the nursery-age children and demonstrated their ICT interactive books. In the final part of the activity, the leader led a review of the activity which raised issues of preparing for a specific audience, and the use of appropriate language. In following up the activity, the leader intended to evaluate the presentations with the learners and make revisions. The group was going to produce science revision materials for next year's Year 6 groups using the same software and skills later in the year.

Learning through designing materials for others is a powerful way to motivate and engage learners with ICT (Harel and Papert, 1991). The task is both meaningful and sufficiently complex for learners to revise and practise a range of skills for a specific purpose. Starting learners as young as possible is important for developing their understanding of key concepts in ICT.

These episodes represent a range of approaches to developing learners' ICT skills. They are progressive in the sense of showing how increasingly complex skills can be developed over the period of their formal education.

Personal attainment

Collected under this heading are the various characteristics of learners that are not evaluated in formal assessments, such as self-confidence, motivation, and ability to work with others or on their own. These characteristics have an impact on other kinds of attainment, and different kinds of activities develop different qualities.

The next vignette, of an activity rated at 3, shows how activities can develop personal characteristics over a period.

Vignette 6: Year 8, grammar school

Topic: Evaluating the design of magazine front covers and websites.

Resources: Room (12 or more machines) and web browsers.

Learners had been involved in a long-term module during which they had used a database, spreadsheet, word processor and desktop publishing program to analyse, evaluate and present information about themselves. They were now about to work on a multimedia presentation, and this was a preparatory activity to evaluate the design of some magazine front pages and websites. The leader introduced the topic by discussing ways in which magazine front covers had been designed, with a cover projected onto both the whiteboard and the learners' monitors. Together they discussed an evaluation sheet which was to be

completed electronically for the various sites. Working on their own, learners evaluated the design of another magazine front cover and two websites out of a possible six. They discussed their results with one another and with the leader, before reporting back to the group.

A range of ICT experience, together with a flexible approach to the use of technology, provides learners with the opportunity to develop their abilities in both collaborating with others and working on their own. Rather than being the focus of the session, ICT is a catalyst that increases the opportunities for leaders and learners to interact in different ways to achieve a clear set of goals.

The final vignette shows the roles that ICT can play within a pedagogical structure that fosters collaboration and interaction between leaders and learners. In this activity, all learners were rated as having made substantial improvement in their curricular attainment, self-confidence, motivation, and ability to work together, and the activity was given attainment ratings of 1, 2, 1 and 1 respectively for each of these factors.

Vignette 7: Year 11, city technology college

Topic: Nazi propaganda.

Resources: Single machine and interactive whiteboard.

The activity began with revision of previous work on Hitler, which consisted of two and a half lessons on Nazi Germany, one lesson looking at chronology and one lesson looking at Hitler's background. In the first phase, the leader used the whiteboard to recap on the main points, and introduced a paper-based activity to sort a randomly ordered timeline. The learners worked individually or in pairs on the task to highlight, summarise and classify, and to report back their results to the leader for recording on the interactive whiteboard. Finally the whiteboard was used to show propaganda posters, and the group worked together in directing a student scribe to highlight areas of impact on the posters. The leader signposted key ideas, and later there was a plenary question-and-answer session to consolidate the activity. To follow up the session, the leader planned more analysis of Hitler's propaganda methods, with groups of students choosing one method to research.

ICT is one aspect of this activity, but it is used both as a presentation tool and a focus for discussion in a way that would not be possible with other media. The mix of leader-led discussion and learners working in groups, with their results being shared with the whole group, aids learners' confidence, motivation and collaboration.

An alternative approach to developing individual learner's personal attainment is through their free use of ICT in computer clubs. In an infant school, year 2 children had a very popular lunchtime session that was supervised by a special needs assistant. Learners of all attainment levels could choose to work on literacy or numeracy, with software selected for their level, or they could play games using the same web-based software. Informal discussions between the assistant, who was familiar with each child, and the learners helped learners consolidate their experience and created a positive atmosphere. The session was given an attainment rating of 1 for motivation, self-confidence and autonomy.

Conclusion

Reviewing these vignettes it is worth noting that they are snapshots of activities which range from 'all pupils achieved substantial improvement' (attainment rating 1) through to 'most pupils achieved some improvement' (attainment rating 6). By any account they are all successful activities, and they present a sample of the range that was seen. From these vignettes, factors that seem significant for attainment include:

- the appropriate integration of ICT into the activity through careful prior preparation of skills and selection of resources
- a switch from teacher-centred to learner-centred approaches
- a range of settings from single machines through to rooms with more than 12 machines being used, which provide varying degrees of flexibility to meet the requirements of the chosen activity.

Appendix 5: Measures of leaders' and learners' confidence with ICT

Two sets of ICT 'confidence' scores were created from the leaders' and learners' profiles.

Leaders' confidence score

Five fields of the profile were used:

- *ICT usage* type: administration, preparation, presentation, teaching and assessment.
- *Access to technology*: frequency of use during a school week
- *Types of access*: home and school.
- *New Opportunities Fund (NOF) score*: indicated whether the training had been completed, partially completed or not undertaken.
- *Years in teaching*
- *ICT experience in teaching* in years

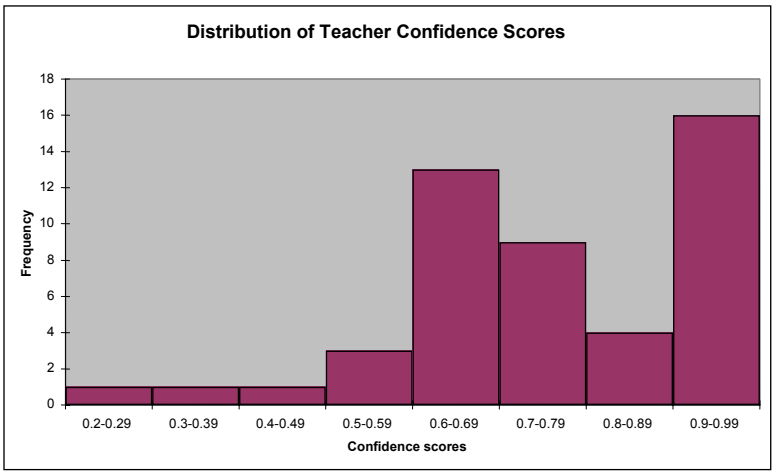
The score was calculated using the rule:

$$\left(\frac{\text{ICT usage type}}{5} + \frac{\text{ICT experience}}{\text{Years in teaching}} + \frac{\text{Access to technology}}{2} + \text{NOF score} \right)$$

The average, rounded to two decimal places, was adjusted to give a score between 0 and 1 by subtracting 0.01. The distribution is shown in Table 1 and Graph 1.

Score	0.2–0.29	0.3–0.39	0.4–0.49	0.5–0.59	0.6–0.69	0.7–0.79	0.8–0.89	0.9–0.99
Distribution	1	1	1	3	13	9	4	16

Table 1: Distribution of leaders' confidence with ICT



Graph 1: Leaders' confidence scores for the use of ICT

Three main groups of leaders emerged from this measure:

- *Leaders' confidence group A* represents those leaders with a long experience of teaching, but who made comparatively little use of ICT for teaching or administration. Eleven per cent of the leaders were placed in this group. (scores:0.2-0.59)
- *Leaders' confidence group B* represents those with a long teaching experience but a shorter, albeit extensive, ICT experience. Forty-seven per cent of leaders were judged to be in this group. (scores:0.6-0.79)

- *Leaders' confidence group C* consists mainly of leaders who had used ICT for all of their relatively short teaching career. Forty-two per cent of the leaders fell into this category. (scores:0.8-0.99)

Learners' confidence score

A measure of learners' confidence with ICT was developed based on the formula:

> number of software applications met + frequency of ICT use in formal settings + frequency of ICT use in informal settings within school

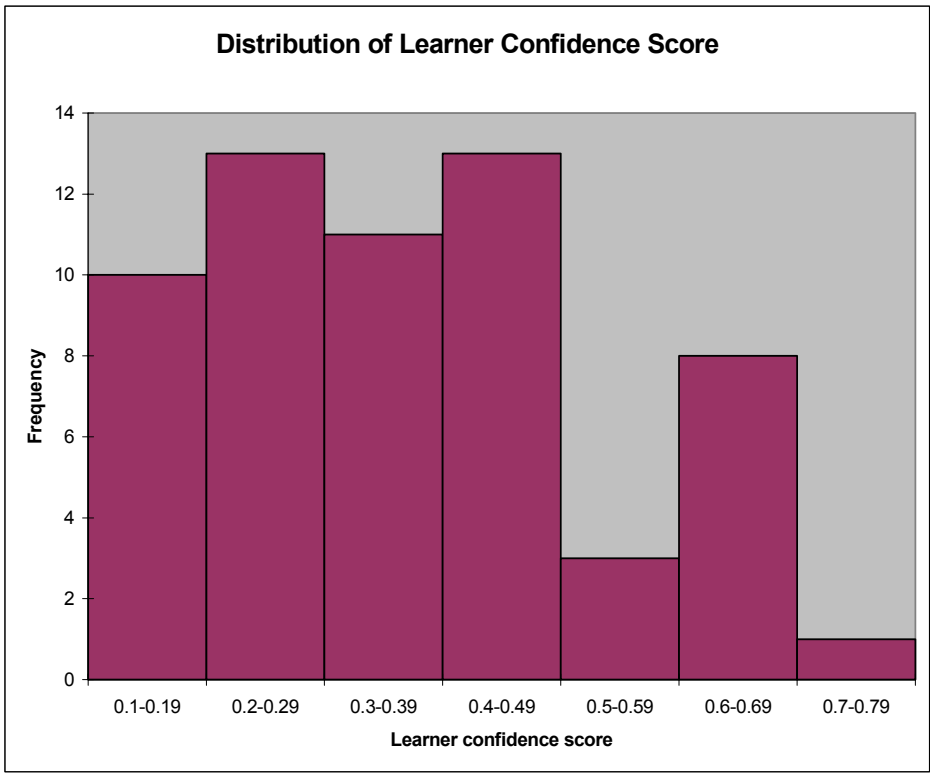
As with leaders' confidence, this was adjusted to give a score between 0 and 1, by taking an average (rounded to two decimal places) of the number of possible selections for:

- software applications (small software, content free, programming, integrated learning systems, CD-ROMs, presentation, handheld technology, web browsers, generic)
- frequency of ICT use in school. (eg, everyday, more then 3 times per week, twice per week, once per week, once per fortnight)

Table 2 and Graph 2 show the results.

Score	0.1–0.19	0.2–0.29	0.3–0.39	0.4–0.49	0.5–0.59	0.6–0.69	0.7–0.79
Distribution	10	13	11	13	3	8	1

Table 2: Distribution of scores for learners' confidence



Graph 2: Learners' confidence with ICT

The values ranged from 0.1 to 0.79, with peak groups at 0.2–0.29 and 0.4–0.49, each containing 22 per cent of the values.

The score does not deal with learners' non-formal experience, since this proved difficult to collect systematically. The scores indicate a spread in the lower half of the range, which may change if their non-formal experience is taken into account.

Appendix 6: Potential for attainment using ICT

The 'potential for attainment' score (PA) was used to analyse the range of attainments across the 24 categories generated by:

- hardware arrangements: single, group (2–5 machines), suite (6–12 machines), room (more than 12 machines)
- leaders' confidence score (A, B or C)
- structure of an activity's phase 2 (leader centred or learner centred).

The score was obtained by multiplying the average attainment for each category by the relative frequency with which the category occurred within a particular hardware configuration. For example, under the 'room' configuration for curriculum attainment, in the category of leader's confidence (group B) and a learner-centred phase 2 structure:

The potential for attainment score

(PA) = average attainment * relative frequency

which gives:

PA = 4.5 * 4 /11 = 1.64

For comparison purposes we also found the average potential for attainment in hardware configuration. In the example above:

the average 'potential' attainment (APA) = average attainment for room configuration/Number of activities in the room configuration

which gives:

APA = 3.36/11 = 0.33

Comparing the two scores shows that the PA for this category is higher than the APA, and gives a way of accessing the relative weight of the PA score.

Tables 1–6 show the breakdown of PA scores of various types set against type of hardware, leader confidence, and phase 2 structure split into two types:

- Pedagogy Type 1 (Pedag1): Leader-centred approach.
- Pedagogy Type 2 (Pedag2): Learner-centred approach.

In each case, the APA scores are provided for comparison. It is worth noting that the lower APA scores occur for those categories having the larger number of activities in each attainment type. This means that the difference between the APA score and highest score indicates a significant potential for developing learners' attainment with ICT.

Potential for curricular attainment

	Hardware Arrangements							
	Single		Group (2–5)		Suite (6–12)		Room (>12)	
	Pedag1	Pedag2	Pedag1	Pedag2	Pedag1	Pedag2	Pedag1	Pedag2
Leader Con A	0	0.21	0	0.67	0	0	0.45	0.55
Leader Con B	0.43	***1.5***	1.33	***2.16***	0	0.5	0.18	1.64
Leader Con C	0.86	1.33	0	0	0	***2***	0	0.82

Table 1: Potential curriculum attainment scores set against type of hardware, teacher's confidence, and phase 2 structure

The APA scores for the single, group, suite and room configurations were 0.31, 0.69, 0.63 and 0.33 respectively. The scores in ***bold italic*** show the highest potential scores for each hardware configuration.

The highest scores occurred:

- in all four hardware configurations for those activities that had a phase 2 teaching and learning structure that placed the learner at the centre of the activity (Pedagogy type 2)
- in three of the hardware configurations for leaders who had a long experience of teaching and learning (group B).

Potential for ICT attainment

	Hardware							
	Single		Group (2–5)		Suite (6–12)		Room (>12)	
	Pedag1	Pedag2	Pedag1	Pedag2	Pedag1	Pedag2	Pedag1	Pedag2
Leader Con A	0	0	0	1.33	0	0	0	0.48
Leader Con B	0	2	0	***4***	0	***5***	0.28	***1.56***
Leader Con C	0	***4***	0	0	0	0	0.04	1.08

Table 2: Potential ICT attainment scores set against type of hardware, teacher's confidence, and phase 2 structure

The APA scores for the single, group, suite and room configurations were 2, 1.78, 5 and 0.14 respectively. Seventy-four per cent of the activities occurred in rooms, and the relatively high averages in the other three categories are the result of the comparatively few activities that they cover.

The highest scores occurred in:

- all four hardware configurations, for those activities that had a phase 2 teaching and learning structure that placed the learner at the centre of the activity (Pedagogy type 2)
- three of the hardware configurations for leaders who had a long experience of teaching and learning (group B).

Potential for the development of self-confidence

	Hardware Arrangements							
	Single		Group (2–5)		Suite (6–12)		Room (>12)	
	Pedag1	Pedag2	Pedag1	Pedag2	Pedag1	Pedag2	Pedag1	Pedag2
Leader Con A	0	0	0	0.6	0	0	0.23	0.46
Leader Con B	0.36	***1.36***	***1.8***	1.4	0	1.25	0.42	***1.42***
Leader Con C	0.71	1.21	0	0	0	***1.75***	0.15	0.96

Table 3: Potential self-confidence attainment scores set against type of hardware, teacher's confidence, and phase 2 structure

The APA scores were: single (0.26), groups (0.76), suite (0.75) and rooms (0.14). The highest scores occurred in:

- three hardware configurations, for those activities that had a phase 2 teaching and learning structure that placed the learner at the centre of the activity (Pedagogy type 2)
- three of the hardware configurations, for leaders who had a long experience of teaching and learning (group B).

Potential for the development of motivation

	Hardware Arrangements							
	Single		Group (2–5)		Suite (6–12)		Room (>12)	
	Pedag1	Pedag2	Pedag1	Pedag2	Pedag1	Pedag2	Pedag1	Pedag2
Leader Con A	0	0.33	0	0.33	0	0	0.21	0.55
Leader Con B	0.4	***1.27***	0.33	***2.83***	0	1.25	0.14	***1.52***
Leader Con C	1	1.2	0	0	0	***2***	0	1.21

Table 4: Potential motivation attainment scores set against type of hardware, teacher's confidence, and phase 2 structure

The APA scores were: single (0.28), groups (0.58), suite (0.81) and rooms (0.12). The highest scores occurred in:

- all four hardware configurations, for those activities which have a phase 2 teaching and learning structure that placed the learner at the centre of the activity (Pedagogy type 2)
- three of the hardware configurations, for leaders who had a long experience of teaching and learning (group B).

Potential for the development of collaboration

	Hardware Arrangements							
	Single		Group (2–5)		Suite (6–12)		Room (>12)	
	Pedag1	Pedag2	Pedag1	Pedag2	Pedag1	Pedag2	Pedag1	Pedag2
Leader Con A	0	0	0	0.4	0	0	0.28	0.5
Leader Con B	0.6	***1.3***	1.2	***2***	0	0	0.11	0.78
Leader Con C	0.1	0.8	0	0	0	0	0.11	***1.28***

Table 5: Potential collaboration attainment scores set against type of hardware, teacher's confidence, and phase 2 structure

The APA scores were: single (0.28), groups (0.72), and rooms (0.17). There were no scores for suites. The highest scores occurred in:

- all three hardware configurations, for those activities that had a phase 2 teaching and learning structure that placed the learner at the centre of the activity (Pedagogy type 2)
- two of the hardware configurations, for leaders who had a long experience of teaching and learning (group B).

Potential for the development of autonomy

	Hardware Arrangements							
	Single		Group (2–5)		Suite (6–12)		Room (>12)	
	Pedag1	Pedag2	Pedag1	Pedag2	Pedag1	Pedag2	Pedag1	Pedag2
Leader Con A	0	0.4	0	0	0	0	0.32	0.21
Leader Con B	0	0.6	***1.67***	1.33	0	0.5	0.26	***1.58***
Leader Con C	0.4	***1.4***	0	0	0	***1***	0	0.74

Table 6. Potential autonomy attainment scores set against type of hardware, teacher's confidence, and phase 2 structure

The APA scores are: single (0.28), groups (1.33), suite (0.38), and rooms (0.16). The highest scores occurred in:

- three hardware configurations, for those activities that had a phase 2 teaching and learning structure that placed the learner at the centre of the activity (Pedagogy type 2)
- half of the hardware configurations, for leaders who had a long experience of teaching and learning (group B).

This represents a departure from the pattern observed in the other tables regarding leaders' confidence categories, although the structure of teaching and learning shows a similar pattern to the other types of attainment.

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