'Educational IT' Research Methodology: Looking Back and Moving Forward

Book Section

Part 3

Methodological approaches and applications

Chapter 15

Educational information technology research methodology: looking back and moving forward

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Introduction

This chapter examines some of the key methodological trends in the educational IT literature in order to help us gain a better understanding of existing research and to inform future research design. The issue of research methodology is crucial to any study, as it underpins the types of questions that can be addressed and the nature of the evidence that is generated (Clark, *et al*. 1984, Shulman 1986). The approach employed also has implications for the uses that can legitimately be made of research outcomes. For example, within an empiricist approach it would be assumed that one could make generalisations based on research findings, while this may not even be a goal for many interpretivist researchers (Schofield 1993). Thus, the purposes underpinning one's research need to inform the methodology employed (Underwood and Underwood 1997).

Robson (1993) described three different purposes underpinning research in the social sciences: exploratory research, which aims to seek new insights, ask questions and find out what is happening; descriptive research, which aims to provide an accurate profile of the situation or phenomenon being studied; and explanatory research, which aims to explain the phenomenon being studied, often in the form of causal relationships. All three purposes are evident in the educational IT literature.

Robson went on to suggest that the purpose of the research helps to determine the most appropriate research strategy. He loosely linked case studies with exploratory work, surveys with descriptive studies, and experiments with explanatory research. The use of experimental approaches in educational research, which by definition rely upon the control of variables, have been widely criticised from both pragmatic and philosophical perspectives. While even advocates of experimental approaches to research in education recognise the limitations of the use of artificial contexts, experimental approaches based within authentic educational settings have been criticised because of practical and ethical problems associated with attempts to control the variables in such contexts (e.g. Hammond 1994; Venezky 2001). Philosophically, experimental

approaches have been criticised on the basis that they ignore the differences between people and the objects of study of the natural sciences (Fenstercacher 1986), and thus the assumptions underlying experimental approaches are argued to be invalid, at least when applied to the study of social phenomena. Conversely, qualitative approaches have been said to lack validity or reliability due to the subjective nature of the data collection and analysis. These are paradigmatic arguments, which are often expressed as a debate about the extent to which quantitative and qualitative approaches can be combined (Bryman 1988). Understanding and coming to a view about this argument is an important step in deciding upon the most appropriate research methodologies for studying educational IT.

The Quantitative vs Qualitative Debate

Robson (1993) noted that quantitative research is typically seen as involving approaches to data collection such as experiments and surveys. He also identified that qualitative research is typified as involving case studies, observation and interview.

Bryman (1988), in summarising the debate about the extent to which one can legitimately combine quantitative and qualitative research, identified two different ways of viewing them. The first sees the distinction between qualitative and quantitative research as relating to different ways of collecting data, and claims that one needs to choose the best method on the basis of the technical constraints of each. The alternative stance is that quantitative and qualitative research represent incompatible views on how the social world should be studied: 'they are essentially divergent clusters of epistemological assumptions, that is, of what should pass as warrantable knowledge about the social world' (Bryman 1988: 5).

Thus, at one extreme there are researchers who argue that one can mix and match between quantitative and qualitative research (e.g. Tesch 1990; Underwood and Underwood 1990). At the other extreme are those who argue that quantitative and qualitative research, because of their different underpinning assumptions about ontology and epistemology, represent distinct and incompatible paradigms (e.g. Scott and Usher 1999). In the middle are researchers, such as Hammersley (1992), who dispute the significance of the differences between the philosophical underpinnings of quantitative and qualitative research and thus argue that they are not mutually exclusive, and others, such as Willis *et al*. (1999), who while appearing to acknowledge paradigmatic incompatibilities, still argue that we should attend to research from all paradigms.

Examination of this debate suggests that one could consider research at a number of different levels. For example, Strauss and Corbin (1998) distinguish between methodology and methods, while Scott and Usher (1999) differentiate between ontology, epistemology, strategy and methods (see Table 15.1).

Table 15.1 Different 'levels' at which one can consider research

Strauss and Corbin (1998)	*Scott and Usher (1999)*
Methodology: a way of thinking about and studying social reality	**Ontology:** the nature of the world: how it is **Epistemology:** how we know the world: views of knowledge
Methods: a set of procedures and techniques for gathering and analysing data	**Strategy:** research design using certain types of reasoning **Method:** techniques for collecting and analysing data

Both these classifications distinguish between philosophical and technical levels at which one can consider research.

Figure 15.1, which is adapted from Scott and Usher's (1999) classification, shows another formulation of the different levels at which researchers operate and the ways in which these levels relate to each other. It illustrates the way in which different approaches to research are underpinned by different views of ontology and epistemology, and highlights that they make use of a variety

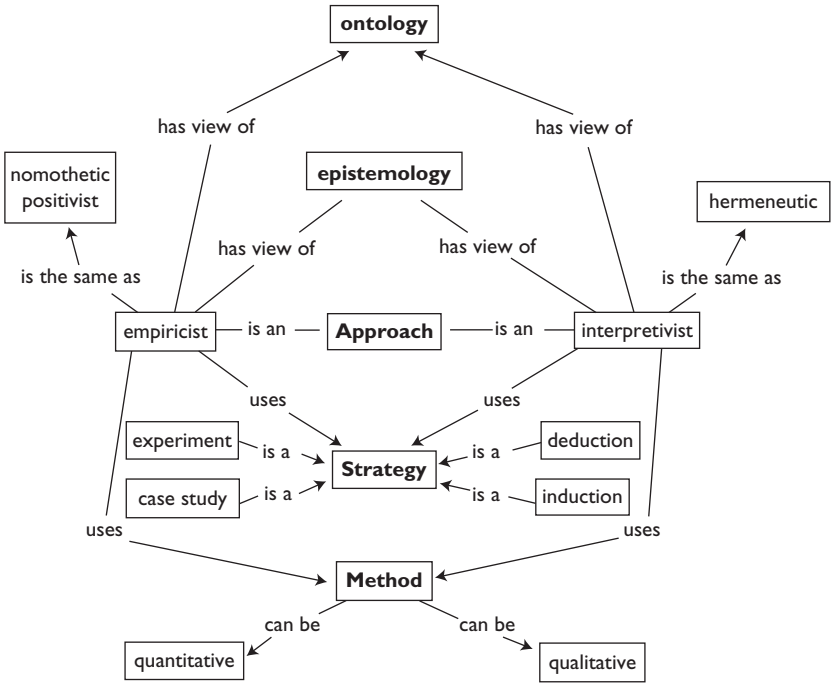

Figure 15.1 Relationship between different terms relating to research in social sciences.

of research strategies and methods. Figure 15.1 does not attempt to include all the different approaches, strategies or methods that are available, but provides illustrative examples.

Part of the explanation for the apparent disagreement about the extent to which quantitative and qualitative research could be combined appears to be due to ambiguity about the level of research that was being discussed and which paradigmatic labels should be applied. For example, Tesch (1990), unlike most authors, was only considering the Method level when she defined quantitative research as being that which uses numerical data, while qualitative research is any research that uses data that cannot be expressed in numbers. Willis *et al*. (1999), whilst applying the labels quantitative and qualitative at the Method level, argued that paradigms are not about data sources (quantitative vs qualitative) but about what you do with those sources. Scott and Usher (1999) made the paradigmatic distinction between qualitative and quantitative research at the Approach level, which they tied in closely with the ontological and epistemological levels.

Even more problematically, many researchers do not clearly distinguish between these levels. For example, Robson (1993) appears to merge the Approach, Strategic and Method levels, when he characterises quantitative research as being based on a 'scientific' approach in which theories are built through the formulation and testing of hypotheses through empirical means, as opposed to qualitative research, within which he states that the theories emerge from the enquiry, and boundaries between data collection and analysis are often blurred.

Further confusion comes from the different ways in which terminology is used within the literature. For example, Miller and Olson (1999) use the terms Methodology and Methods without making it clear what they mean by them. Ambiguity also arises where terminology is used differently by different authors, as illustrated in Table 15.2.

Despite the apparent differences between authors, there appears to be considerable agreement once confusion about terminology and the level being discussed are removed. For example, Erickson's (1986) argument is that two researchers could both use observation – writing descriptions of what they see happening – but end up with very different descriptions because their orientation (Approach) is different. Willis *et al*. (1999) agree with this, in that they are essentially arguing that different techniques at the

Table 15.2 Comparison of terminology used in the literature on research

Author	*Terminology*			
Strauss and Corbin (1998)	Methodology		Methods	
Scott and Usher (1999)	Ontology	Epistemology	Strategy	Method
Erickson (1986)	Method		Technique	

Method level (i.e. those that use numerical data and those that do not) are compatible but that there are incompatibilities as you move up to the Approach level and above.

Thus, there appears to be fairly wide agreement for the stance taken by Scott and Usher (1999) who argue that different approaches (as in Figure 15.1) represent different and incompatible paradigms. For example, empiricist and interpretivist approaches are based on different ontological and epistemological positions, as summarised in Table 15.3. However, research strategies and methods are not paradigmatic in themselves. For example, an interpretivist can use both quantitative and qualitative data. Scott and Usher (1999) make the case that it is not the method that is used that determines the approach, but the way in which that method is employed.

Taking this stance overcomes much of the apparent disagreement within the literature in relation to quantitative and qualitative research and allows one to take full advantage of the widest range of research methods, while remaining within the paradigmatic confines of one's particular research approach.

However, it does not mean that any strategy can fit within any approach. The ontological and epistemological stance underpinning each approach has implications for the research strategies that are deemed appropriate. For example, an experimental research strategy, involving control groups or laboratory conditions, would be linked with an empiricist approach and would not fit within an interpretivist one.

This exploration of the quantitative-qualitative debate helps to clarify the research methodologies that are appropriate to use within this field. In the next section, we take a more detailed look at the methodologies used in previous research.

Table 15.3 Comparison of ontological and epistemological stances of empiricists and interpretivists (based on Scott and Usher 1999: 2)

Empiricists	*Interpretivists*
One reality that can be known (determinancy).	Multiple realities.
No contradictory explanations (rationality).	Multiple accounts.
The more objective and the less subjective the better (impersonality).	All data collection involves subjectivity – in the sense that what one perceives is dependent upon one's beliefs, knowledge and interests.
Research is the making of knowledge claims in the form of generalisations from which predictions can be made, and events and phenomena controlled (prediction).	Research is about providing rich descriptions. All understandings are situated and thus not generalisable. At best one can establish consensus in certain contexts.

Historical overview of research methodologies in the field of educational IT

There has been a considerable amount of research into the use of computers in education (Moseley, *et al*. 1999) and the literature within the field is extensive (McFarlane *et al*. 2000; Condie and Munro 2007). The research methodologies evident within the literature on computer use follow the methodological trends evident within educational research literature in general. This includes confusion about key differences between different research approaches, as illustrated for example by Willis *et al.'s* (1999) taxonomy of research approaches (Table 15.4), which appears to confuse key distinctions between them. For example, they seem to assume that the definitions of empiricism and interpretivism are based on methodological considerations compared with Critical Theory, which is defined in terms of ideology.

This confusion within the literature also involves ambiguity about the level of description of the research process, as discussed in the previous section. For example, Hadley and Sheingold (1993) identify two main types of research that are relevant to the question of the impact of IT in schools: case studies and surveys. Their description of case studies and surveys (see Table 15.5) suggests

Table 15.4 A taxonomy of research into IT in education (summarised from Willis *et al.* 1999)

Critical Theory Ideological stance, often focused on power relationships and equity issues	
Empiricism Methodological stance, based on a positivist notion of epistemology and belief in scientific methods. Generally making use of sampling techniques, survey methods and/or controlled variables.	**Interpretivism** Methodological stance, based on post-modernist notions of epistemology: 'realities are local, transitory, and contextually based' (Willis *et al.* 1999: 34). Often based on 'constructivist' views of learning. Tends towards qualitative methodologies.

Table 15.5 Summary of Hadley and Sheingold's (1993) categorisation of research on the impact of IT in schools

	Surveys	*Case Studies*
Scale	Large	Small
'Sample' and hence generalisability	Representative and hence generalisable	Atypical and hence not generalisable
Timescale	Snapshot	Longer timeframe
Outcomes	Broad trends with little detail	Interesting insights
Implicit research approach	Empiricist	Interpretivist

that they equate case studies with an interpretivist approach and surveys with an empiricist one. These examples are typical of the lack of clarity about research methods within the field.

Within the educational research literature as a whole, there has been a shift from predominantly empiricist approaches to a greater reliance on interpretivist ones. Within the USA this shift was reversed as a result of the *No Child Left Behind Act* (US Congress 2002). This legislation placed a major emphasis on 'scientifically based research', which involved large quantitative studies and the use of control groups.

Clark *et al*. (1984), in their review of the school effectiveness literature, identified the initial shift from empiricist approaches which predominated pre-1970 to interpretivist approaches which were in the ascendancy post-1970. Walker (1992: 98) argued that 'the old order based on an empirical-scientific-positivist doctrine has lost its grip on the field,' but that 'no new doctrine has yet achieved dominance'.

In the area of computer use in schools these general trends apply, although it is still the case that survey based studies dominate the literature even in the period between 1970 and 2002 (Chalkey and Nicholas 1997, Miller and Olson 1999, Moseley *et al*. 1999, Willis *et al*. 1999, Cuban 2001, Pelgrum and Anderson, 2001). There have also been a small number of studies that combine survey and case studies (e.g. Watson 1993, Harrison *et al*. 2003, Somekh *et a*l. 2005).

In the late 1990s a number of research papers began to appear that fit a Critical Theorist approach (e.g. Selwyn 2000). Willis *et al*. (1999) argued that critical theory was ideological rather than methodological (see Table 15.4) and this is true to the extent that its focus is on critiquing society in order to bring about change. However, Horkheimer (1937) in his seminal essay on critical theory makes it clear that critical theory rejects logical positivism and thus places it within an interpretivist approach.

Another development has been a greater emphasis on practitioner-based research, as evidenced in the UK by the provision of funding at a national level to support teacher-researchers (Foray and Hargreaves 2003). Practitioner-based research is often mistakenly labelled as action research. Action research is 'the study of a social situation with a view to improving the quality of action within it' (Elliott 1991: 69) and involves cycles of planning, acting, observing and reflecting. Whilst the aims of practitioner based research often correspond closely with those of action research, the strategies used often differ.

Somekh (2000) suggests that despite the changes in research strategies and methods over the previous twenty years, research findings within the field have not changed substantially. This view also seems to be supported by Twining *et al*. (2006) who go on to identify the need for more systematically implemented and longitudinal research using a mix of methods within an interpretivist approach.

Methodological Issues and Future Research

It is clear from the computer use in schools literature that there are a number of issues relating to the ways in which research has been carried out and the uses to which the outcomes of research can be put. For example, a number of researchers have identified trends within the field that need to be borne in mind when trying to make sense of this research. Moseley *et al*. noted that:

> When researchers initiate ICT activities for pupils they tend to use computer assisted instruction or computer assisted learning software where learning content is presented to pupils. By contrast, when teachers carry out action research, the preferred choice is more open ended or generic software.
>
> Moseley *et al*. (1999: vii)

Hadley and Sheingold (1993) noted two distinct features of research that used case studies: the introduction of technology for a particular purpose, which was often constructivist in orientation; and working in contexts where high levels of resourcing (equipment and staff) were available (e.g. the *Apple Classrooms of Tomorrow* project (ACOT)) and which looked over a long time frame. This analysis was echoed by Miller and Olson's (1999) classification of research in this area, which they argued fitted into three main categories:

- *Visions* – often tended to ignore or criticise teachers (e.g. Perelman 1992); investigators were often advocates rather than 'neutral researchers' (e.g. BECTA).
- *Lighthouse projects* (e.g. ACOT) – atypical in terms of the level of resourcing and the enthusiasm and commitment to the technology of the people involved; often unclear which variables lead to changes.
- *Large scale studies* – often relied upon survey methods, though some (e.g. Watson 1993; Harrison *et al*. 2003; Somekh *et al*. 2005) used both qualitative and quantitative techniques.

This latter group they sub-divided into those that were investigating factors involved in innovation and those that were trying to bring about systemic change, often with a particular view of how technology should be used.

A number of issues emerge from these analyses that are relevant to the design of research into educational IT. These include practical concerns relating to experimental strategies, such as the control of variables, and questions about causality in educational contexts. Other issues include: the validity and reliability of data, particularly in the context of self-evaluation or self-reporting; the level of detail provided; and the stance of the researcher.

An experimental strategy is based on the notion of being able to control variables using one of two techniques. The first involves the use of artificial

contexts, such as laboratory experiments, whilst the second involves the use of control groups in 'real world' contexts. Due to substantial problems with the external validity of using the results from artificial contexts to inform practice in schools, the use of laboratory experiments has become much less prevalent when it comes to research into computer use in schools, and would seem to be inappropriate for developing educational IT use.

The use of control groups in pure experimental designs involves the allocation of samples from the target population to different conditions. In 'real world' educational settings this is normally impossible for practical and ethical reasons. To overcome this problem researchers often adopt what Campbell and Stanley (1966) call quasi-experimental strategies in which existing groupings are used (e.g. whole classes of children). Efforts are then made to account for, and thus eliminate the effects of, differences between the groups that might otherwise render the findings invalid. However, the notion that one can control all of the variables within an educational context is highly problematic (e.g. Hammond 1994, Pisapia *et al*. 1999, McFarlane *et al*. 2000).

The related problem of the difficulties of establishing causal links pertaining to computer use in schools is commonly noted within the literature (e.g. Clark *et al*. 1984, Schrag 1999, Lewin *et al*. 2000, McFarlane *et al*. 2000, Venezky 2001). Underwood and Underwood (1997), while accepting the complexity of educational contexts and the problems associated with the control of variables, claim that experimental strategies are still appropriate in education, as they are in medical research. Their argument is that well-designed experimental studies can help to illuminate causal relationships. They argue that if computers lead to changes that in turn bring about educational benefits 'the understanding of the specific causes of change is a secondary issue, even if the causes are at all separable' (Underwood and Underwood 1997: 34). In other words, they are claiming that it does not matter that one cannot control all of the variables, so long as you can show that there is a learning gain associated with computer use.

Experimental and quasi-experimental strategies generally involve statistical analysis of the data. Underwood and Underwood (1997), for example, argue in favour of the use of certain statistical techniques, such as multivariant analysis, within the context of well-designed experimental studies, to reveal that an intervention has had an effect. The inappropriate use of statistical techniques has been criticised in the literature: for example, Mitchell (1997) identifies this as one of the key mistakes that is common in the field. One example of this is the use of correlations to draw conclusions about causal relationships. This is clearly illustrated by a number of related studies looking at the relationships between IT in schools and students' attainment (e.g. see BECTA 2007). In some of BECTA's own research (e.g. 2000, 2001, 2002) the key approach was to show a correlation between the level of IT resourcing in schools (as judged by OFSTED inspections) and the attainment of pupils

on national tests (SATS or GCSEs). In each case, they reported finding correlations such as those illustrated in Figures 15.2 and 15.3.

The implication that because there was a correlation between the quality of IT resourcing and pupils' attainment there was a causal connection

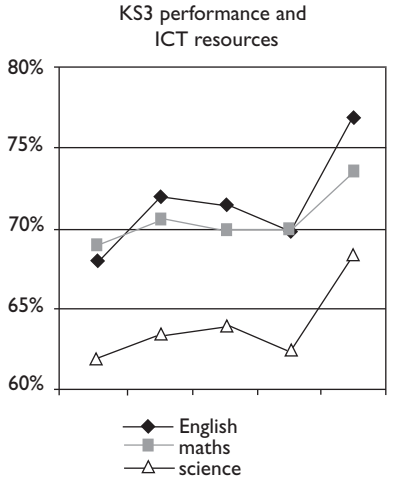

Figure 15.2 Percent children achieving L5 or above at KS3 (redrawn from BECTA 2001: 11).

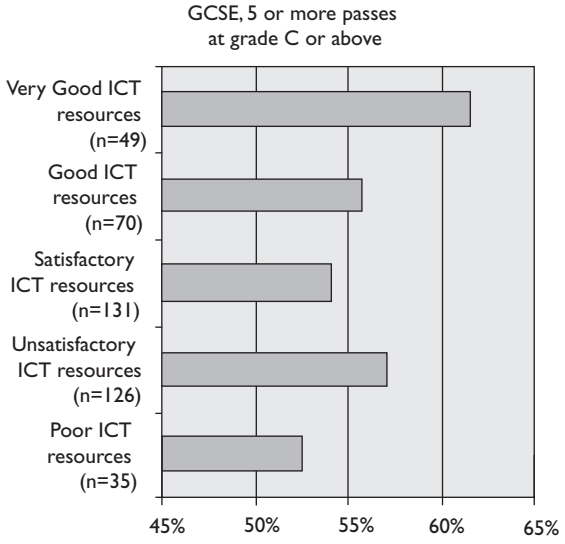

Figure 15.3 Percent children achieving 5 or more GCSEs at grade C or above against quality of IT resources (redrawn from BECTA 2001: 11).

between them is flawed, because 'Even if a correlation can be established between two variables, it is still not possible to assert, in an unproblematic way, that the one caused the other to happen' (Scott and Usher 1999: 80). Indeed, following the publication of the first of these reports by BECTA, the UK Publishers Association (Watson 2001) demonstrated even larger correlations between the levels of spending on books in primary schools and pupils' achievements on SATs, using the same statistical techniques that BECTA had used.

Underwood and Underwood (1997) argue that quantitative methods can tell us if something has changed, but that in order to understand how or why the change took place one needs to use qualitative methods. Scott and Usher agree that understanding social phenomena requires the use of qualitative techniques:

> Quantitative researchers are not able to deal with the intentions, beliefs and propositional attitudes of social actors. If they try to, they are engaged in processes of reification, packaging and ultimately distortion. This suggests that data-collection processes which do not involve quantification will have to be employed to fully understand the nature of the social world.
>
> Scott and Usher (1999: 92)

As has already been identified, surveys are commonly used by researchers interested in computer use in schools. Whilst all surveys, by their very design, rely upon respondents to provide information, a particularly common form of response is self-assessment (Harris 1999; Cuban 2001). For example, using surveys to explore the impact of increased levels of computer resourcing on the quantity and quality of computer use would require teachers to self-assess the quantity and quality of computer use before and after the addition of extra equipment. There are a number of potential problems with self-assessment, including overly subjective responses and misrepresentation.

Where rating scales are not clearly explained, there is a danger that responses may be overly subjective (Harris 1999). For example, if asked to rate the impact of IT on pupils' learning on a scale that included the options 'None', 'Little' and 'Substantial' it would not be surprising if there was variation in the way in which respondents interpreted those terms. Not only is the boundary between 'Little' and 'Substantial' unclear, but the options are also skewed with little scope for discrimination. In particular, it is unclear how one would rate the impact of IT on pupils' learning on this scale if it fell somewhere between 'Little' and 'Substantial', as it easily might.

Cuban criticises surveys on the basis that they 'are essentially self-reports and so are prone to inflation and selective memory' Cuban (2001: 120). In essence, he is arguing that misrepresentation may take place either deliberately or unwittingly. For example, if a head teacher is asked to 'indicate on

average how many minutes per week each child in your school spends using a computer', she is unlikely to know the answer or have enough information to be able to calculate the answer; it is much more probable that the best she can do is make a 'reasonable' estimate. In making that estimate, the head teacher may overestimate the amount of computer use, either by unconsciously giving too much weight to the times she has noticed children using computers or deliberately, perhaps because she is concerned about the under use of such an expensive resource. Indeed, Chalkey and Nicholas (1997: 98) found that 'there is a tendency for respondents to overestimate their use of computers'.

Inevitably, there are power-relationship issues in any research, and these may exacerbate misrepresentation issues. For example, the UK government carries out regular surveys of computer use in schools, which are based on self-reporting by head teachers (or their representatives). Given the UK government's position as the key funder of these schools, it seems possible that head teachers will be keen to respond in ways that will cast their school in a good light. Indeed, comparing the UK government data (DfES 2001) with that collected by an 'independent source' (BESA 2001) suggests that the government data on expenditure exaggerated the levels of investment (see Table 15.6).

In comparing these figures it is important to remember that the DfES data related just to England, whilst the BESA data covered the whole of the UK. One would thus have expected the BESA figures for total expenditure to be higher than the DfES ones, which was not the case. This suggests that caution needs to be exercised about the use of surveys that involve self-reporting, particularly in contexts where the respondents might be keen to be seen in a good light.

Another potential disadvantage of surveys is that they tend to provide a broad but shallow picture (Hadley and Sheingold 1993), which may lack the level of detail needed in order to differentiate between key factors that play an important part in computer use in schools. Lewin *et al*. (2000) identify this as

Table 15.6 Comparison of the levels of expenditure on IT in primary and secondary schools in 2001, based on data from different sources

	Primary schools		*Secondary schools*	
	UK (BESA 2001)	*England (DfES 2001)*	*UK (BESA 2001)*	*England (DfES 2001)*
Average total IT expenditure per school	£7,620	£10,300	£34,640	£60,300
Estimated total IT expenditure	£175.6 million	£186 million	£156.5 million	£210 million

being a particular problem in the context of identifying the impact of IT on learning because of the important role that the way in which software is used has on the learning outcomes and 'because the micro features that differentiate between classrooms or activities where effects are occurring and those where they are not are too specific to be picked up by the research design' (Lewin *et al*. 2000: 23).

The need for greater detail in the data on computer use in schools has lead to there being substantial support in the literature for the use of observational techniques (e.g. Chalkey and Nicholas 1997, Kent and McNergney 1999, Miller and Olson 1999, Moseley *et al*. 1999, Willis *et al*. 1999, Cuban 2001). This fits with the use of case studies, which enable aspects of educational IT use to be explored in depth, using a range of quantitative and qualitative techniques. Cohen and Manion (1989) highlight a particular strength of case studies as being that they allow the complexity and subtleties surrounding computer use in educational contexts to be described.

Action research, along with other forms of practitioner research, also tend to provide rich pictures of practice. Such accounts help to illuminate the ways in which technology is being used, which seems to be critical in determining the effects of technology in education (Wegerif 2003). In addition, Somekh (1995) argued that action research is particularly well suited to the study of innovations and in particular the use of IT in education because it is more likely than 'conventional' research to form the basis of recommendations that can be implemented easily in practice.

In their discussion of action research Selwood and Twining (2005) highlight a key distinction between evaluation and research as being that research is informed by and builds upon the wider body of knowledge in the field. One criticism that could be levelled at much so-called practitioner research is that if fails to meet this requirement. McDougall and Jones (2006: 355) extend this criticism to include much of the research in educational IT, which they identify as being determined to neglect or deliberately ignore its own history. They go on to quote from Underwood (2004: 140) when they say '[I]n the excitement of the new we appear not to want to look back and learn from the lessons of the past'.

Conclusions

From the brief overview provided in this chapter, it is clear that there has been a great deal of confusion within the educational literature in general, and the educational IT literature in particular about the nature of research and the methods that are most appropriate to use. This is partly due to confusion and lack of clarity in the terminology used, but also to the fact that the whole area of educational research is contested. Ultimately, this is due to paradigmatic differences in views of 'how the world is' (ontology) and views of knowledge (epistemology).

In order to make sense of the educational IT literature you need to bear in mind the contexts in which particular studies took place: the approach and underlying stance of the researchers should inform your interpretation of their work.

In deciding on how to conduct your own research, you need to be clear about your underpinning ontological and epistemological positions, as these will determine the overall approach that you will adopt. Your approach will, in turn, have a direct bearing upon the strategies that you can legitimately use, the ways in which you view different research methods, and the sorts of claims that you can make based upon your data. As will become clear in subsequent chapters of this book, there is no one agreed 'correct way' to research educational IT.

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