THE USE OF TIME DATA IN ASSESSING THE EFFECTIVENESS OF IT RESOURCES IN A SIXTH FORM COLLEGE

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ABSTRACT

This study develops and explores a technique of individual time data analysis (ITDA) which can be used as a tool for demonstrating the effectiveness of resource use in further education. The study focuses on Information Technology (IT) resources and investigates effectiveness by surveying individual students' reported resource use and exploring the relationship between this and performance. Using quantitative data from a positivist methodological standpoint, the study aims to provide techniques which are accessible to educational practitioners.

Two surveys were used in a West Midlands sixth form college. The first was conducted in the academic year from September 1998 and the second from September 2006. Data was gathered on students' use of IT resources and performance was measured using students' value added results. This information was used in a statistical analysis which evaluated the effectiveness of the students' resource use. The conclusions differed for the two surveys. The 1998 survey showed that those students who spent a greater proportion of their time using IT resources were more likely to achieve better value added results. However, the 2006 survey appeared to show the opposite.

As a result of the two surveys the ITDA technique was evaluated and recommended for further development by practitioners.

DEDICATION

To my wife and daughter for their patience.

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LIST OF ABBREVIATIONS

BECTA	British Educational Communications and Technology Agency
EMA	Education maintenance allowance
FE	Further education
FEDA	Further Education Development Agency
FEFC	Further Education Funding Council
FERL	Further Education Resources for Learning Programme
HTML	Hypertext markup language
IT	Information technology
ITDA	Individual time data analysis
MIS	Management information system
NLN	National Learning Network
NVQ	National Vocational Qualification
OFSTED	Office for Standards in Education
PC	Personal computer
PDA	Personal digital assistant
SMS	Short messaging services
SPSS	Statistics Package for Social Scientists
VAS	Value added score
VLE	Virtual learning environments
VOIP	Voice over internet protocol

1 INTRODUCTION

1.1 Individual time data analysis

This study develops, describes, tests and evaluates a means of assessing the effectiveness of the use and deployment of information technology (IT) resources, based on an analysis of the reported use of these resources by individual students. The method described provides its own substantive conclusion, but can also be used as a model which could be adapted to suit the analytical needs of practitioners in varying circumstances. As the method is based on an analysis of the time individual students spend using the resources to be evaluated, I have called the method described "individual time data analysis" (ITDA).

1.2 Resource use and accountability

All resources in educational institutions are limited. In the public sector, a chain of accountability stretches from those who deploy resources in the classroom back through their managers and ultimately to central government who are accountable to the public for their management of public finances. At each level in this chain there is a need for anyone involved in decisions about resource use to show that resources have been used effectively (Clayton *et al.,* 2008)

At the bottom end of this chain are those teachers and departmental managers who are responsible for deploying resources in the classroom. They are often required to demonstrate that their decisions about the deployment of resources are effective. For instance managers may need to review resource use within their department; external bodies such as the OFSTED inspectorate may require evidence of effective practice or it may be required in bidding for external grant funding. The need to show effective use of resources is particularly true with IT resources, as the capabilities and availability of technologies are constantly changing. Advances in information technology are often motivated by the search for ever greater efficiency. The phenomenal advances in computer technology in the last twenty years have meant that all kinds of new alternatives to traditional classroom education have emerged.

1.3 IT resources – constant change

The capabilities of computer technology are at present developing rapidly and this rate of development has shown no sign of lessening. There are powerful economic forces towards development in the IT industry such as the need to avoid market saturation through the frequent upgrading of products and the symbiotic relationship between chip manufacturers and software developers relying on each others' advances to create new markets. These mean that the speed of development of IT resources looks set to continue for the foreseeable future. Three likely future developments are briefly described below.

Increases in data storage and processing speed

Increases in data storage and processing speed ensure that the delivery of curricular content can take full advantage of the potential of multimedia. Servers can now provide high quality audio and video content at differing rates to suit the needs of students so that students in the same class can progress at a speed optimised for their ability. As well as working individually on their own machines, students can work within a shared IT environment where, for instance, content can be delivered by a teacher using an interactive whiteboard which can process feedback from students using electronic voting systems.

Increases in inter-connectedness

Advances in networking and wireless technologies along with increased data transfer speeds mean that accessing shared resources and the internet is far easier. Often in the past a classroom might have one or two Personal Computers (PCs) which were left idle because they were not connected to the vast sources of information available (see, for instance, Savage, 2007). Already multimedia content is available online and can be accessed freely through wireless networks so that students use laptops to access that content without a great deal of preparation or setting up. This trend is set to continue as broadband speeds increase and the volume of content available increases.

Developments in user-friendliness and portability

Accessing the resources described above can be made easier with the introduction of new portable devices which perform many of the functions which previously could only be carried out using a PC. For instance, classes are already using hand-held devices to search the internet and communicate with each other. Students now make use of their own devices which they carry with them (Connole *et al.*, 2008). The trend is for the technology which can access and process information to become more widespread and integrated into devices such as mobile phones (Evans, 2008) which have not been associated with classroom practice in the past.

It may be that such developments described above contribute to increases in the efficiency of IT resources as educational tools and the pace of development suggests that if IT has an impact on education now, it will have an even greater impact in the future.

1.4 The need for new approaches to the evaluation of effectiveness

The need for accountability in the provision of educational resources and the ever-developing nature of IT resources mean that methods of evaluating effectiveness also need to be continuously developed. Those responsible for resource management at the lower level -for instance at the class level - often have the least time and resources available to evaluate the effectiveness of their resource use. This need is particularly noticeable in further education where there is an emphasis on greater flexibility of delivery and a history of poor resourcing (FEFC, 1996). As students progress through the education system there is more choice both in terms of the curriculum and in the method of attendance and delivery. In schools in England and Wales the national curriculum is fairly prescriptive up until Key Stage 3 (students aged 14). There has been a move in recent years to free up the national curriculum in Key Stage 4 (14 – 16) as a preparation for students' further education or training. In the wake of the Tomlinson Report (DfES, 2004), space has been made in the curriculum for greater choice and more vocational education is available to students. Once students in England and Wales reach 16 they move onto further education. Education for the 16 – 19 age group is transitional. Students are free from the prescription of the national curriculum and have yet to move into the finalisation of their career choices through vocational training or higher education. It is in further education that students are first exercising a greater degree of choice about the curriculum they study and their future. It is also at this time that they first experience a greater degree of freedom in their choices about how they use the learning resources provided by the institution in which they study.

A review of previous studies is made in the literature review in Chapter 2. These reveal gaps in the methods of evaluating the effectiveness of IT use which are available to educators at the college and classroom level. To summarise, there are three approaches to such evaluation in the literature. Firstly there are intervention studies which compare an intervention or new approach to resource use in the classroom with other approaches and a control group which has no intervention. These interventions may be at the classroom level for instance Segers *et al.* (2004) or Ecalle *et al.* (2009), or may focus on comparing institutions (e.g. Levin *et al.* , 1984) Other studies may employ a meta-analysis approach (e.g. Kulik and Kulilk, 1991; Liao, 2007). While these have the advantage of following a well established positivist tradition, the intervention can be disruptive to. Other studies in the tradition of Rutter *et al.* (1979) such as Van Houte (2004) and Mangan (2005) have tended to look on a wider level such as the institutional effectiveness models investigated in the school effectiveness study literature or are educational comparisons on a national or international level (e.g. Neilson and Tatto, 1991; Kyriakides and Chalambous, 2005). These approaches are part of a mainstream orthodox definition of effectiveness in the UK, but the techniques developed have tended to be more appropriate for larger scale studies. A third means of dealing with such an evaluation is that of action research in which practitioners use reflective methods in an emancipatory approach to improve the education process. This approach has a validity, but may not provide a practitioner with the tools which needed to demonstrate effectiveness in a working environment where notions derived from the school effectiveness field are the norm. The methods of evaluating the effectiveness of the deployment of resources can be developed further within the school-effectiveness paradigm, especially for IT resources at the classroom level, and on individual students' use of those resources.

The further education sector, which is also my own field of experience, was therefore a good place to investigate such methods. There has been a sparsity of research in the education sector (Martinez 2001) and a need for more practitioner research has been identified. In the further education sector the variety of the subjects studied, freed from the constraints of the national curriculum, and the greater autonomy given to students means that students' behaviour in using resources is more varied. This means that a method of evaluating effectiveness which is based on measurements at the level of the individual provides the greatest degree of flexibility and scalability.

1.5 Developing the methods

The first stage in the process of developing individual time data analysis (ITDA) was to identify the methods to be used. The choice was influenced by the desire for a methodology which could be used by practitioners. The methods also needed to be applicable to different technologies as new ones emerge. Practitioners may, on occasions, need to both evaluate a particular new technology and make use of the general mix of technologies available to their students. It was advantageous to develop methods which could be adapted to a range of situations, for instance, by a class teacher looking at the use of technology by a particular class or by a group of classes, or by a head of department who wants to look at all classes within that department. The intention was to devise a methodology that would, therefore, be workable with small as well as large groups, and the results of the study be capable of aggregation. The methods also needed to make a comparison possible between the different groups studied. Methods which approach students' resource use on an individual basis would meet these requirements. Although this study concerned the use of IT resources specifically, in devising the method I was mindful of its potential application to a range of different educational resources, for example paper-based as well as IT based educational materials.

2 LITERATURE REVIEW

2.1 Introduction

The study focuses on Information Technology (IT) resources and investigates effectiveness by surveying individual students' reported resource use and exploring the relationship between this and performance. In this context, effectiveness means optimising the use of resources in achieving goals. Institutions have the task of delivering education in conditions where resources are limited and need to allocate these between alternative schemes or projects. Resources which are used effectively will enable the institution to achieve more of its intended goals. In order to make these decisions, managers would benefit from a means of establishing which methods of deploying their resources are the most effective. An effectiveness study can potentially provide a tool or set of tools for evaluating the effectiveness of differing methods of resource use.

The technology which is used in education is constantly changing and developing. In particular, information technology (IT) has, over the last twenty years, been one of the fastest moving technologies in terms of its development. In a field such as this, there is a pressing need for those involved in developing and implementing the techniques by which it is applied to employ effectiveness studies in decision making. These studies are informative on two levels. Firstly, they evaluate the effectiveness issue that the specific study has been designed to investigate, allowing decisions to be made and secondly they add to the general picture of effective practice in resource use in educational institutions, providing that studies have some generic characteristics so that comparisons can be made.

Those who are involved in the delivery of education, who are also responsible for making decisions over resource use, have a particular need for relatively simple analytical tools to evaluate effectiveness, because their time is mostly taken up with delivery rather than evaluation. Although in an action research context , Clayton *et al.* (2008), note that the time needed is cited by practitioners as being a barrier to taking up research. Tools need to be developed which can be consistently and easily applied to different implementations of changing applications. This study aims to explore how such a tool might be used and, in order to do this, there must be an initial review of what tools can be garnered from the literature on effectiveness.

First, there follows a discussion of the meaning of the term effectiveness as it has been used in the literature, in order to establish what an effectiveness study can achieve. Following this there is a discussion of the changing nature of IT resources and how they have been and can be deployed in the delivery of education. This is followed by a review of the literature on the effectiveness of IT use. The issues raised by the literature then lead to the development of a set of research questions for this study.

2.2 Effectiveness

Issues surrounding effectiveness in education can be discussed under the following headings:

i) What is meant by effectiveness in education?

ii) Who measures effectiveness in education?

iii) How is effectiveness measured and what measures can be used?

2.2.1 What is meant by effectiveness in education?

Stated simply, the answer to the question "what is meant by effectiveness in education?" is that an activity is effective if it achieves its aims (Simkins, 1981; Hoyle, 1980). In a review of the literature defining effectiveness, Creemers and Kyriakides (2007) noted that historically there has been a split in the literature between school effectiveness and teacher effectiveness. In this categorisation, school effectiveness can be taken to refer to research which investigates how school-wide factors such as policies and perceived mission affect students' performance, and teacher effectiveness research which investigates processes under the control of the teacher such as expectations, teaching techniques and resource use, although this split has been remedied somewhat in more recent studies (e.g. De Jong, 2004; Opdenakker and Van Damme, 2000) which acknowledge the hierarchical nature of the multiple layers (classroom, school etc.) involved in the organisation of education.

Teddlie and Reynolds (2000) identified three strands in school effectiveness research. School effects research investigates the relationship between institutions and performance, attempting to distinguish the effect of the school from other factors such as a student's socio-economic background and classroom effects. Effective schools research investigates the processes involved in education which contribute to the effectiveness of schools as institutions. School improvement research investigates the processes by which schools improve or become more effective. The latter strand can be distinguished from the other two by intervening in the processes, rather than merely observing them. Categorisations such as these are useful as a means of exploring the scope of the fields, although it should be noted that having rehearsed such categorisations, much of the literature then suggests closer links between the different strands. For instance, Reynolds *et al.* (1996) surveyed the existing literature on school effectiveness and noted that on the one hand, there is literature which is largely quantitative and looks at those factors which make a school effective at a particular moment in time and on the other hand, there is a practitioner led movement towards school improvement based on practitioner "folklore" and experience. The authors proposed that in recent years there has been more of a movement toward school improvement schemes which are based on factors drawn from school effectiveness research and that convergence between the strands is ongoing (p152). Creemers *et al.* (1998) noted that school effectiveness and school improvement have become more closely allied and Creemers is inclined to categorise all the literature as studying "educational effectiveness" (Creemers *et al., 1998;* Creemers and Kyriakides, 2007). This study draws on literature from all three of Reynolds' strands, and so the term educational effectiveness may be a more useful label for the field in which it lies.

The history of educational effectiveness studies stretches back to the early twentieth century. However, the modern field incorporating Reynold's three strands is usually taken as starting with studies such as Rutter *et al.* (1979) in the UK and Brookover *et al.* (1979) and Edmonds (1979) in the USA. These studies were a reaction to the literature over the previous fifteen years (e.g. The Plowden Report, 1967 in the UK and Coleman, 1966 and Jencks, 1972 in the USA) which suggested that the key determinant of student performance was factors outside school such as socio-economic background and intelligence. This history is surveyed in, for instance, Teddlie and Reynolds, *2000;* Creemers and Kyriakides, 2007 and Coe and Fitzgibbon, 1998). The Rutter study, called "Fifteen thousand hours" in reference to a child's school years, and the studies from the US, found that some of the variation in performance between students could be attributed to schools. The research in educational effectiveness since that time has been refining that finding, although there is a consensus that around 15% of the variation of student performance can be attributed to or at least correlated with school effects. A further body of effectiveness research, usually using multi-level modelling techniques has concluded that teacher effects outweigh school effects (e.g. Teddlie and Reynolds, 2000; Luyten, 2003). In Reynolds' classification, school effectiveness studies try to isolate the size and extent of the "school effect" and the effective schools studies try to identify what factors contribute to that effect. School improvement studies try to extend the effectiveness of schools by introducing initiatives based on the factors identified as contributing to school effects. Thomas (1990) defined school effectiveness studies as consisting of input/output studies; studies of schools as organisational frameworks; studies of the institutional framework and effective schools studies. Over the last thirty years, school effectiveness research has developed by incorporating the idea of context to try and distinguish factors external to the institution from those internal to the institution, and has accepted multi-layer modelling as the norm. Multi-layer modelling acknowledges that the reality which social scientists investigate is multilayered (Noortgate, 2005), and uses statistical tools to separate measured effects of the different layers of the education system (e.g. class, school, district).

Over the last thirty years, effectiveness research has had distinctive emphases in different countries (Reynolds, 1996). In the UK the school-effectiveness has become strongly associated with Government education policy through the intervention of the OFSTED inspectorate and other agencies (e.g. Teddlie and Reynolds, 2001, Thrupp, 2001, Scheerens *et al.*,2001, Slee and Weiner 2001), whereas this has not been the case elsewhere. Stringfield and Herman (1996), in a review of school effectiveness research in the USA, listed various approaches to school effectiveness studies; analyses of large data sets - international comparisons; longitudinal studies on a federal level; school effects databases and studies which attempt to ascertain variables which affect the effectiveness of schools. The study also noted that government interventions at federal level have been viewed as generally helpful. It should be noted that when international comparisons with large data sets are carried out, the data sets must be based on comparable tests. US studies suffer from the lack of a standardised curriculum based test to compare with, for instance, GCSEs in England and Wales, although the Scholastic Achievement Tests used for university entrance are sometimes used. In The Netherlands, school effectiveness research exists in an environment largely disassociated with government policy; however it should be noted that "...The Dutch education system, which is enforced by the constitution, precludes government interference in educational objectives.(Scheerens and Creemers, 1996 p. 190)". In the Netherlands there has been considerable emphasis on building up a theoretical model of educational effectiveness – notably the Creemers Model (Creemers, 1994). Other countries with a tradition of education effectiveness research include Australia, Hong Kong and Cyprus. It is in the nature of education systems, which are usually national in their character, to form independent traditions, but in the field of educational effectiveness, these traditions do not exist in a vacuum, and there is considerable international dialogue (Townsend, 2001).

Since educational effectiveness can be broadly defined as achieving educational goals in the most efficient way, the first issue to clarify is the nature of educational goals. The picture is complicated, because the aims of the educational process are not clear cut. The aims expected from even the same process of education may differ depending on whose viewpoint is taken; for instance, the aims of a college in providing a course of A-levels may differ from those of a student studying for those A-levels. The student may wish to gain sufficient grades to ensure that they can progress onto the higher education course of their choice but the college may want to maximise the performance of the student as measured, for instance, by the points value of the student's A-levels to show that they have been educationally effective. The student may only need a C grade in order to gain acceptance on the University course or training scheme to which they wish to proceed and are happy to achieve that; while the college, knowing their student's potential to get a B may have this as their performance aim. In addition, effectiveness can be measured on different levels, ranging from the macro (the British system of further education) to the micro (a particular class or group of students at a specific college) and each level may have a differing aim.

The achievement of the educational aim pursued becomes the test by which effectiveness is judged. This can be seen as beneficial from the perspective of both those who provide education and its recipients. To each person, education might bring different benefits (Thomas, 1990) and the extent to which education is effective might be said, therefore, to be the extent to which it delivers the desired benefits. Sammons *et al.* (1995), focused the definition of effectiveness on the rate of student progress towards the institution's educational aims; the adding of value, the measurement of this being by testing. Thomas (1990) noted that effectiveness criteria may vary depending on the viewpoint of the evaluator and illustrates the need for an awareness of both internal and external effectiveness. A consequence of this is that there is no wholly agreed definition of the criteria of effectiveness. The central factor in judging effectiveness is identifying the educational aim(s) to be achieved. The issue of how effective education is at achieving desired aims is, therefore, often determined by who is making the choice as to what are the desired aims:

> The debate about criteria for judging effectiveness may be much more about controlling the direction of the education system than about the best means of evaluating its performance. (Thomas, 1990 p.28)

There appear to be two basic perspectives from which educational effectiveness is viewed in the research literature. Firstly, the extent to which aims are achieved from the perspective of the providers of education and, secondly, the extent to which aims are achieved from that of the end users of education. There may well be a tension as to the aims of the process between those who provide education and those who receive it.

2.2.1.1 Effectiveness from the perspective of providers

Education is provided by a hierarchy of agencies. Governments are elected with a mandate to run the education system but some of the management and policy-making is delegated to local educational authorities who, in turn, delegate some decisions to individual schools or colleges. The implementation of that policy is put in place by teachers or other people who deliver education. For those at the point of delivery, the aims against which they evaluate their effectiveness are usually those of the wider education system, as they have little discretion within the curriculum to formulate their own educational aims. Thomas (1990) pointed out those individual educators may also feel a "moral obligation" to assess their own effectiveness, in addition to it being a means by which they can defend their decisions and performance. There is a strand in the effectiveness literature which discusses the need for practitioners to formulate their own effectiveness criteria, although this strand exists largely outside the UK. Kyriakides (2002), writing from a Cypriot perspective, discussed teachers' self-evaluation of their own effectiveness. Cheung and Cheng (2002) in a series of case studies from Hong Kong noted that self-management including setting of goals was associated with enhanced performance. However Meuret and Morlaix (2003) noted that in France self-assessment of effectiveness is not commonplace and is disliked by teachers across Europe. In the UK self-assessment forms the first stage of the OFSTED inspection regime for schools. In further education (FE), in the UK, since the introduction of competition in colleges through incorporation in 1993, the need to evaluate has also become connected to the need to improve performance in a "quasi-market" (Grey and Warrender, 1995). This is also true within the school sector; the aim of governments since 1979 has been to encourage quality, diversity, increasing parental choice, greater autonomy for schools and greater accountability (Thomas and Martin, 1996). This process has continued since a change of government in 1997; in the government's 2005 education White Paper, Tony Blair wrote: "After 1997, this government extended such accountability …" and "Our aim is the creation of a system of independent non-fee paying state schools …" (DfES, 2005b pp. 2 and 4).

For the most part, educational effectiveness literature takes cognitive outputs as the educational goal against which effectiveness is judged (e.g. Fox, 2004), although an alternative approach using non-cognitive outputs has been proposed (Griffith, 2002; Landeghem *et al.,* 2002). This is discussed in the next section. The most common performance indicators used are test results, such as the Scholastic Achievement Tests in the USA or GCSEs/GCEs in the UK. In The UK, school effectiveness studies have fed into government definitions of effectiveness through the inspection criteria used by regulating bodies such as OFSTED and the FEFC (FEFC, 1993). A further way in which the government encourages institutions to evaluate their effectiveness is through the use of league tables of performance indicators, as a result of which the items reported in the tables become key performance goals.

From the point of view of providers of education in England, therefore, a set of criteria has been established by which the achievement of goals can be measured. These criteria often focus on output measures such as test scores or exam results. These performance indicators may be adjusted for input to show the value added by the institutions and to account for contextual factors. These criteria have been adopted by government in the formation of education policy and this "official" description of effectiveness pervades the evaluation of the system at all levels, down to the practitioner in the classroom (Luyten *et al.*, 2005). Value added measures will be considered further in the methodology chapter.

2.2.1.2 Effectiveness from the perspective of participants

Approaching effectiveness from the perspective of the providers of education and arriving at ”official” definitions of effectiveness has not been without criticism. Scheerens *et al.*(2001, p. 132) note that in school effectiveness research, educational goals are taken as a given. Elliot (1996) questioned whether learning can be judged by its outputs. Taking an individualistic and subjective view of learning avoids making teaching and learning a “coercive process of social induction” (p. 209). Luyten *et al.* (2005) agreed with this criticism and added, firstly, that the school effectiveness paradigm can also be criticised because it assumes that it can distinguish between facts and values and that it is feasible to predict outcomes. Secondly, they noted that the ties between school effectiveness research and policy makers are too close, compromising scientific objectivity. They also noted that the “school effect” , that is the influence that can be attributed to the school on the achievement of educational goals as noted by Rutter *et al.* (1979), is seldom greater than 15%, although this has varied in different studies over the last 30 years. This leaves 85% of the difference in school performance attributable to the influence of other factors. Slee and Weiner (2001) note the inherently political nature of School effectiveness research. By concentrating on the effectiveness of schools, it is argued, social inequalities leading to poor education can be ignored. Marks (2006) noted that socio-economic background influences student performance as well as ability. His study focused on the differences which social background makes on the educational experience of students. One way of viewing these controversies is to see two distinct approaches: school effectiveness research, concentrating on the processes within schools and a sociological perspective which is concerned with the wider role of educational institutions in society. Thrupp (2001) noted that school effectiveness research had not adequately addressed these criticisms from outside the field. Teddlie and Reynolds (2001) rebuffed these criticisms by asserting that, for instance, social background is now built into most models of school effectiveness though contextual variables.

Another approach to effectiveness is to look from the perspective of the participants in the education process. Education as an experience is consumed directly by learners – students - and indirectly by, for instance, parents of children in schools and employers as users of the output of the education system. Studies from Rutter *et al.* (1979) onwards have used various process measures to try to assess the satisfaction of students, parents, employers and other interested parties with the learning experience and the extent to which students feel they are achieving their own educational aims. While these can possibly be imputed, for example, by analysing attendance and retention figures – data which are also published by the government - inferring student satisfaction from these proxies is of limited usefulness. The correlations on which they are based are generally very low and factors are hard to put into operation successfully. Self-rating of learning satisfaction is more commonplace and may be used to ask students directly about their satisfaction with different educational methods. Writing from an American perspective, Griffith (2002) noted that although educational effectiveness has most usually been measured in terms of test results, a judgment of effectiveness based on students' social development can also be measured using a statistical analysis of a study of students' feelings on the education process. Landeghem *et al.* (2002) in the Dutch context also argue that non-cognitive measures should be used. Other examples of this approach include: Yaverbaum and Liebowitz (1998), Rada (1998) and Muilenburg and Berge

(2005) who use student perceptions of factors which hindered their learning to compare the effectiveness of on-line and traditional learning methods.

In a democratic society, it might be hoped that educational aims set by the providers of education would overlap greatly with those of the participants in the education process to whom they are ultimately answerable. There is, however, a potential tension between the differing aims of the participants in the education process and those of the providers. The aims of the participants vary on an individual level whereas the aim of providers need to be simple enough for their achievement to be broadly demonstrable.

2.2.2 How is effectiveness measured and what measures are to be used?

As has been noted above, school effectiveness research looks at the effectiveness with which institutions achieve educational goals and, as such, looks from the perspective of the providers of education. The measure of effectiveness has therefore tended to be based on the outputs, for instance in the UK context, GCSE and GCSE exam results. Reynolds and Teddlie (2000) in their review of school effectiveness studies, noted that in the development of the modelling of effectiveness over the previous thirty years, measurement by output has been tempered by consideration of input to measure the value added and by a variety of contextual measures such as social background. Cuttance (1992) distinguished between a “standards model", for instance the use of league tables of raw results to compare institutions and an “intake adjusted” model, using value added measures, which attempts to isolate the impact of the education process from the student’s ability in measuring performance. Cuttance argued that a wide range of criteria is needed in order to validly compare data. Fitz-Gibbon (1992) demonstrated just such a wide variety of criteria in her development of an information system to provide for school self evaluation. Gorard (2005) criticised the use of value added scores as a means of demonstrating effectiveness, by showing statistically that they are a mere proxy for raw results, and do not isolate school effects from intake effects as they claim to do. Marks (2006), in comparing the education systems of thirty different countries, used standardised output measures from each country to measure performance, as well as a standardised measure of socio-economic background. Coe and Fitz-gibbon (1998) criticised much of the research up until the time of their writing for failing to model effectiveness adequately, saying that equating value added with effectiveness is merely to attribute effectiveness to that part of the student's progress which has not been explained by any of the variables used in the study. This means that any unmeasured factors will be confused with apparent gains in the raw score. School effectiveness studies often list correlations between variables and performance, but do not identify causes. The authors recommend the design of experimental interventions to explore effectiveness more thoroughly. Coe and Fitzgibbon (1998) also noted that in the 1990s the model of effectiveness in schools may have relied too heavily on lists of common features in effective schools. Such lists have been refined and reproduced in studies such as Sammons (1995) and Reynolds *et al.* (1996), for example in Sammons *et al.* (1995) the factors associated with effective schools were listed as being:

1. Professional leadership
2. Shared aims and visions
3. A learning environment
4. A concentration on teaching and learning (Reynolds *et al.*(1996) adapted this as "high quality teaching and learning")
5. Purposeful teaching
6. High expectations
7. Positive reinforcement

8. Monitoring of student progress
9. Awareness of pupil rights and responsibilities
10. Home-school partnership (omitted by Reynolds *et al.*(1996).
11. A "learning organisation" i.e. a culture of staff development **

Coe and Fitz-gibbon argued that this approach ignored “within school” variations associated with classroom and teacher effects. Creemers (1994) provided a theoretical model for the processes which might be associated with effectiveness in schools. The Creemers model consists of 30 variables across multiple levels. This is further explored in a number of studies (De Jong *et al.,* 2004; Kyriakides, 2005). Creemers and Reezigt (1998) identified time on task as an important variable when measuring whether opportunities to learn have been used. Kyriakides and Chalambous (2005), in a paper exploring multi-level modelling techniques for comparing education effectiveness, identified time spent as a variable which could be used in effectiveness studies, particularly at the student level. However, they observed that it is difficult to assess how much of the time a student spends on a task is actually being used effectively, because it is difficult to measure their mental processes. In the last 10 years multi-level modelling of effectiveness factors has become the norm beginning to address this issue (e.g. Opdenakker and Van Damme, 2002; Nortgate, 2005 and Wong and Li, 2008). Muijs *et al.* (2005) found that previous studies on teacher effectiveness had too broad an approach, attempting to discern “generic characteristics of effective teachers” (p. 51). It is important to note, as did Stringfield (2007) that this field is constantly developing, arguing that any science develops in the four stages: firstly description of the phenomena, secondly explanation of the phenomena, thirdly testing of the hypothesised explanations of the phenomena and lastly control of the phenomena. He argued that the study of educational effectiveness is at the third stage.

In addition to the institutional models of school effectiveness listed above there are studies which compare the effectiveness of one particular educational method with others. These intervention studies can in theory take the perspective of the provider or the participant in education. In practice, such studies often take the perspective of the provider of education, because it is the provider which has control over the choice of methods used. Often the measures of effectiveness in these studies rely on the standard input and output measures which are commonly used in the education system studied, allowing comparisons to be made more easily. Intervention studies are discussed in greater detail in the context of the effectiveness of IT in education below. On the wider, institutional scale, meta analyses comparing the effect-sizes of intervention studies can be used as an alternative way of measuring effectiveness (Seidel and Shavelson, 2007).

2.2.3 Modelling effectiveness in this study

In the review above it has been established that literature on effectiveness has many dimensions. There follows a discussion of where this study is to be placed in the context of this literature. The purpose of this study is to explore the use of a tool for evaluating the effectiveness of IT resources in the context of further education in the UK. Placing this in context, therefore, requires a discussion of the meaning of effectiveness in this study. When practitioners are required to demonstrate the effectiveness of their methods or the resource use within their control, they are being required to look at effectiveness from the perspective of the institution. As has been argued above, effectiveness from the perspective of the providers of education means educational outputs measured in terms of the value added. As such effectiveness in this study needs to be measured using a value added performance indicator. As will be noted in the discussion of methodology in Chapter 3, studies of effectiveness can be said to vary in two dimensions: scale and the degree of intervention needed. As a tool to be used by practitioners, this study needs to be small scale and not require intervention, which would distract from a practitioner's primary task. Slavin (2008) noted that in the sort of intervention studies carried out by practitioners with small sample sizes, there is a danger that where different treatments are assigned to different classes it is possible to confound the effects of the intervention with teacher or class effects. As noted, effectiveness for the practitioner will be judged externally using criteria derived from educational effectiveness studies, particularly the multi-level contextual orthodoxy of the school effectiveness field. School effectiveness studies are usually large scale, allowing for a multi-level approach; however, a practitioner will not be able to distinguish class level effects from student level effects because it is unlikely that enough classes will be included in the study for class level variables to be statistically valid. It has been noted that most of the variance in performance occurs at the student level (De Jong *et. al.*, 2004) It may be better, therefore, to choose a simple performance indicator to measure value added and gather data on other variables which may also have a relationship with performance and investigate these relationships alongside the main relationship to be investigated. In the case of this study this is the relationship between the time spent using IT resources and performance. A small scale study carried out by a practitioner will generate data that can be aggregated with data from other studies so that a multi-level analysis is possible (as with, for instance Topping and Sanders, 2000, where data from many different schools were aggregated to allow a multi-level analysis). An alternative approach might be to carry out a study deriving from the literature on action research – “Action research tends to play the role of consolidating theoretical resources for practitioners to draw on when analysing and developing practice. However, the practitioner is the ultimate judge of what is useful knowledge” (Yuen-Ling, 2008 p.257), However, the main thrust of much action research is for practitioners to use reflective methods in an emancipatory approach to improve the education process. A review of the papers published in the journal *Educational Action Research* reveals a body of literature which is largely philosophical and would be of little use to a practitioner needing to provide evidence of the effectiveness of his or her practice.

Much of the literature discussed above refers to effectiveness in schools rather than colleges, However such literature as there is accepts that the principles of assessing effectiveness which apply in schools also apply in tertiary education. Martinez (2001), for instance, indentifies the links between school and college effectiveness, but notes that much of the research is “gray literature” i.e. unpublished internal reports and theses.

Having investigated the meaning of educational effectiveness, there follows a review of the literature on the role and use of IT in education, and the effectiveness of IT use in education.

2.3 Information technology

The relationship between IT resources and effectiveness has been an area of much discussion in the literature, and continues to be so because of the speed with which the technology develops. The term information technology is used here to refer to the application of computer and communication technology in the context of education. The following section discusses the possible means by which information technology might change the way education is carried out and, in the process, potentially made more effective. As technology improves, so the potential impact on effectiveness increases. The application of this technology in the classroom often lags behind the development of the technology's potential and so there is a constant movement towards the achievement of a potential which is ever increasing. In 1998 when the college in this study was first investigated, educational institutions were further back on the journey towards the realisation of IT's potential. By 2006, when the second survey was conducted, institutions had developed their use of IT further.

2.3.1 The capabilities of technology

> Technology is not learning. We can be too carried away with the technology and become interested in it to the exclusion of learning. Therefore we should not give primary attention to new hardware developments. The real interest in the computer in learning lies not in its decreasing price and increasing capabilities, obvious to all, but rather in its effectiveness as a learning device (Bork, 1987 pp. 5 - 6).

When new technologies have arisen in the past, educationalists have sought to incorporate them into the process of education (Mapp, 1996). Yet, there is little evidence that these technological changes have radically changed the way in which education is delivered, either in terms of the means or the model of delivery. The most common means of delivery is still a teacher in a classroom with the students (Levin and Wadamy, 2005; Rudd, 2007). The most common method has the teacher using linear teacher-centred methods, although there has been a move away from this in recent years (Van Grinsven and Tillema, 2006). The question arises as to whether information technology is by its nature so different that it necessitates a radical change in these methods or means (Spender, 1996; Bork, 1987). There is a feeling among enthusiasts that educational technology allows radical changes. Loader (1993) noted that technology, which had always been peripheral to education, now allows a move away from teacher-centred learning to more student-centred learning. Prenski (2001, p. 1) argued that the relationship between teachers and students needs to be re-evaluated because there is a digital generation gap between “digital immigrants” and “digital natives” and that “Today’s students are no longer the people our educational system was designed to teach.” Evans (2008), in evaluating the effectiveness of using podcasting to bring educational processes into previously under-used time (for example by listening to lectures on a mobile device while commuting), describes how new technologies can bridge this divide.

In order to investigate this issue it is important to establish what it is that IT technology can do. Bennet (1996) noted that a computer is a machine which is an extension of the human mind. A computer can store more information than is held in the minds of its programmers, and this, coupled with processing speed, means that computers can carry out operations which exceed what human minds could ever do. Tiffin and Rajasingham (1995) note that with the growth in human knowledge, more physical space has been taken up by libraries full of books which can be more economically stored electronically. There are a multitude of illustrations of how digital storage, for instance on CD ROM, can save both space and time in terms of access to information. That storage capacity and processing speed are also improving with time was noted by Gordon Moore in his seminal 1965 article formulating Moore's law: that processor speed will double every eighteen months (Moore, 1965), although Moore's projections only went as far as 1975. By the 1980s, this process of improvement was noted by educators (Bork, 1987), and still applies twenty years later.

The capacity to store vast quantities of data and process it at great speed becomes a useful tool in education when coupled with the ability of a computer to present information and to interact with a learner's enquiries. Coupled with this is the power of programmed instruction to present a carefully ordered flow of information to a student which can be tailored to the individual, potentially avoiding or reducing the problems of students falling behind in class. This was a possibility which gave rise to great optimism amongst educational technologists in the 1960s (Kay *et al.*, 1968), who hoped that "teaching machines" using linear or branching programs of instruction would soon be commonplace. That hope turned out to be misplaced at that time, through lack of adequate technology. Blease (1986) noted that *"no microcomputer is any cleverer than the program it is running at the time"* (p.11) However developments in "artificial intelligence" may soon lead to technology which is capable of adapting to a student's needs and learning from its student (Tiffin and Rajasingham, 1995).

One of the major advances in information technology in the 1990s was the coupling of the storage and processing power of computers with communications technology. This provided two new aspects: the Internet and E-mail. The Internet - linking existing networks to form a global network - vastly expanded the available data which could be accessed. It also provided the potential for delivering information at a distance, eliminating the need for centralised institutions (Spender, 1993). E-mail provided the opportunity for cheap global asynchronous communication (Pedroni, 1995) and enabled the kind of peer-to-peer interaction which takes place in classrooms to occur online (Rada, 1998) and for discussions to take place at a global level (Russell and Cohen, 1997). In the years since 2000, these technologies have flourished on the back of widespread broadband connections with new social networking applications such as "Blogs", instant messaging, tariff-free telephony using the VOIP (voice over internet protocol), and the development of online interactive learning spaces called VLEs – virtual learning environments (Connole *et al.*, 2008). The 1990s also saw a rapid increase in the multimedia capacity of IT resources (e.g. Lehtinen (2001) Simulations (e.g. Park *et al.*, 2009) and gaming (e.g. Paperastergiou, 2009) are now used as educational tools, and experiments have occured in modelling a virtual university using the "Second Life" online gaming environment (De Lucia, 2009). Information technology in 2009 is scalable to suit the circumstances, so that the presentation of information can be done on physical scales ranging from the tiny screen of a mobile phone (Evans, 2008), to projection on an interactive whiteboard (Rudd, 2007).

To summarise, the capabilities of information technology at present and in the context of education are:

- the storage of large quantities of data
- the ability to process that information very quickly

- the capability to present information in a branching, non-linear sequence which adapts to a student's learning style
- the provision of instantaneous communication which can be both synchronous (video-conferencing, instant messaging, VOIP) and asynchronous (E-mail, VLEs)
- the potential access to a large proportion of human knowledge through the World Wide Web
- the capability to enable people to carry out tasks far more efficiently through automation, for instance, the automation of repetitive calculations carried out when using a spreadsheet
- Technology which is scalable and adaptable

Simliar listings occur in Lehtinen (2001) and Vogel *et al.* (2004). Many of these capabilities are recent developments; for instance the World Wide Web technology which allows easy navigation of the Internet only came into existence in 1992 (Pedroni, 1995), six years before the first collection of data in this study. Newer technologies such as social networking sites, podcasting, VOIP, widespread broadband connections and the mobile internet have all been developed in the course of this study. The full potential of these technologies has been explored most fully in speculative projections of future practice. These will be discussed in the next section.

2.3.2 Visions of the future

> The only thing we can be sure of in forecasting the future is that whatever happens will not be what is forecast - which of course, leaves one saying "but why bother?" The answer is that by attempting to visualise the shape we would like the future to have we can influence the shape it actually takes.
>
> (Tiffin and Rajasingham, 1995, p.186)

There is always a danger in extrapolating future use from current trends and capabilities, as so many predictions have failed to come about. However, the possibilities which computers provide for education in the future present choices which must be made in relation to current resource allocation.

The current infrastructure of education is well established (Mapp, 1996). Rudd (2007), in a study of interactive whiteboard use, noted that

> The notion of an approximate 1:30 classroom with the teacher at front "controlling" the lesson through a process of "knowledge transfer" was clearly (and many argue still is) a "given".
>
> (Rudd, 2007, p.9)

Bennet (1996) noted that educators are particularly reluctant to change and this still remains the case (Muilenburg and Berge, 2005; Savage, 2007). This leads to a view that information and learning technology will be incorporated into existing educational structures in much the same way as previous interventions, such as television. In their survey of the attitudes of primary school teachers to a "top down" programme to expand the uses of computers in primary schools in British Columbia, Bryson and de Castell (1998) noted that resistance to the technology is associated with changes to working practices and power structures. However, there have also been arguments that information technology is transforming society so that these old educational structures may no longer be relevant. Tiffin and Rajasingham (1995) argued that we have moved from an industrial society to an information society, citing and building on the work of Bell (1973). They further argue that the infrastructure of public education, where schools and colleges are part of an industrial "transport society", in which people go from their homes to a school in a separate location in order to prepare themselves for the world of work where they move from their homes to a factory or office is itself changing. As communication technology offers the possibility of working from home through "tele-working" or "tele-commuting", so the "transport model" becomes obsolete and creates the possibility of "tele-learning" – their designation of the process of learning from home.

There are, therefore, two main schools of thought with regard to the impact of technology in the future:

- technology will be integrated into current and traditional educational structures such as classrooms and school, or
- technology will lead to radical new practices, entailing new structures.

The literature on possible future development of the role of IT in education suggests that the first of these possibilities might in time give way to the second, with the greater flexibility offered by IT resources meaning that the classroom can reach out beyond existing locational structures creating virtual classrooms and fostering new learning communities. These might retain the institutional structure of the school, with its facilities for social interaction, while using technology to provide "tele-learning facilities". Bennet (1996) envisaged retaining the school as an institution, while replacing the classroom with rooms in which students might use computer terminals as drop-in facilities with a teacher available in a facilitative role, though not necessarily on hand in the room. Pedroni (1996) also agreed that IT will alter the teacher's role into that of a facilitator, while retaining the institutional structure of schools. Thus, while some see the major changes in education as coming about through changes in locale (from school to home), others see the major shift as being away from teachers as gatekeepers of knowledge towards being facilitators of investigative learning by students.

Further perspectives on how new technology has had an impact on teachers and learners have been discussed by, amongst others, Spender (1996) and Peraya (1998). Spender (1996) notes that modern information technology, especially the communications aspects of it such as the World Wide Web, have the potential to breakdown the traditional distinction between “teacher” and “learner”, although Prenski (2001) argues that the teaching profession has not awakened to this yet. It is too early to see whether the potential for breaking down the distinction between teacher and learner will lead to any fundamental changes. In the past a teacher was someone who had learned a great deal of fixed knowledge and was in a position to pass this on to a learner. This was largely due to the fixed nature of the knowledge stored in books. Today, however, documents written using the hypertext markup language (HTML) and published on the Internet can be regularly amended by their authors as more knowledge is discovered. Online encyclopedias such as Wikipedia are created and edited by their users, rather than by peer-reviewed learned authors. Even printed works can be more regularly updated with new print-on-demand technologies. Both teachers and learners are now able to publish and amend knowledge and, moreover, with more documents in the public domain and easily copied, altered and amended, copyright laws on the “ownership” created by authorship are eroded. Peraya (1998) observes that teachers have been turned into facilitators by the ease with which information is communicated via the World Wide Web. Furthermore, he observes, that the nature of text on the Internet - the fact that the

World Wide Web operates through the use of hypertext - has had a great impact on the nature of the teacher-learner relationship. Whereas, previously, teachers were the gatekeepers and guardians of authoritative texts written by experts, now, he argues, they will find themselves acting merely as guides, through a constantly changing sea of knowledge to which both they and their students contribute. Rada (1998), in a study of peer-to-peer learning via electronic discourse, argued for the validity of this process as a learning tool. Spender (1996) also noted that as the new technology makes "on-line" education increasingly attractive, so this will change the authoritative position of teachers who take much of their authority from the visual clues present in a face to face situation. As a result of this lack of superimposed authority, and the increasing competitiveness in the educational market which the Internet provides, teachers may find themselves having to sell their teaching to an open market in much the same way as authors, musicians and other artists. A consequence of this may be the fading away of educational institutions to be replaced by freelance educators as envisaged by Illich (1971). However, the traditional school-based education provides ancillary benefits to society other than education, for instance the care of the young, enabling adults to go out to work. A greater social and economic change would have to occur in society before Illich's "de-schooled" society would become a viable alternative.

There have been hints in these writings that even the existence of educational institutions may be under threat from, amongst others, the film and television industries. Spender (1996) cites the liaison between film director David Putnam's World Learning Network and the Open University (UK). Some experimental work has already been done with computer mediated learning as a direct rival to teacher–mediated learning (Segers *et al.*, 2004).

Thus the second of the predictions identified can be refined by adding that new technology will mean that educational institutions may be replaced by new commercial institutions and freelance educators.

A note of caution needs to be struck when dealing with the optimism of writers such as those discussed above. The conservative nature which has already been noted among education professionals is also present in students. Muilenburg and Berge (2005) note that the greatest barrier to the effectiveness of on-line learning is its lack of social interaction, although Conole *et al.* (2007) argued that the development of peer to peer networking web pages such as MySpace have mitigated this. De Lucia (2009) reports a successful experiment in completely virtual interaction using the "Second Life" online gaming environment to create a virtual university. The radical visions of institutional change discussed above also ignore the resilience of institutions which currently have control over education. Flexible learning methods are increasingly included within the delivery mechanisms of existing educational institutions. Spector (2005) compared different instruction methods (Online: email, threaded discussion forums, online chat sessions, course websites and face to face lectures) logging the time spent by students in each as one of his variables. The study mapped the extent to which, for instance, on-line learning is becoming an alternative to conventional methods.

Younger students are more willing to accept new technology, and so the age group of the students in education may also be either a help or a hindrance to change in the education system.

2.3.3 The use of technology in UK colleges

In order to investigate the effects of changes in IT on the effectiveness of education, a survey of the use of technology needs to be carried out. It is difficult in a literature review to accurately survey current practice because of the rapid pace of change. This section, therefore, discusses a snapshot of best current IT practices in colleges in England as they were at the commencement of this study in 1998, noting changes that have occurred between 1998 and the second survey of 2006. It is evident that practice varies between colleges, and an accurate snapshot can best be gained from reviewing the actual utilisation of resources in the colleges to be investigated, a matter dealt with in the discussions of this study's methodology in Chapter 3. Most of the trends identified in this section are still on-going. One useful source of literature when the selection of colleges in this study was made was the case studies published by the British Educational Communications and Technology Agency (BECTA) under the Further Education Resources for Learning programme (FERL). Although these date from the late 1990s, they were still published on the BECTA website as studies in good practice in 2006. A more recent review of IT use in FE is contained in the National Learning Network (NLN) Report "The developing impact of ILT" (2004) and the BECTA Survey "The ICT and e-learning in FE survey" (2006), which describes the development of these IT utilisation trends.

The previous section identified three possible views of future developments and the potential for these changes can be analysed in terms of those affected most directly by changes in education:

- teachers/ lecturers/ facilitators/ assessors
- students
- colleges

Of course, others such as parents, business and wider society are influential but the main focus in this study is on the experience of direct participants.

2.3.3.1 Teaching staff and IT resources

Bryson and de Castell (1998) noted that changes in practice with regard to IT often need to be imposed from above due to reluctance in the teaching profession, apart from the actions of some enthusiasts. A report by the Further Education Funding Council (FEFC) into IT use (FEFC, 1995) noted a lack of use of IT resources in most colleges, and that most staff merely used IT resources for word-processing their own material rather than in the classroom. A possible reason for this is offered as:

> There is some suspicion that computers and resource centres are being used to drive down teaching hours with the principal aim of saving money (FEFC, 1995 p. 13)

This issue was being addressed in 1998 by such schemes as the "IT champions" project at East Birmingham College, discussed in BECTA (1998). Levin and Wadamy (2005) noted that the slow impact which such schemes have on the rate of acceptance of IT is in part caused by the reluctance of teachers. Staff use of IT resources reported in National Learning Network (2004) was much wider with little reluctance reported; however, it was noted by Savage (2007) that this was still a problem in the context of the teaching of music in English secondary schools. Clearly, the picture is somewhat mixed.

The production of teaching/learning materials is an area which was undergoing a great deal of change in 1998. Grey and Warrender (1995) and FEFC (1996) both reported a shortage of electronic courseware and doubt the quality of a great deal of course software on CD ROM as it appeared to be directed at a largely American market. A report by the National Learning Network (2004) did not report a lack of software but a lack of training as being a hindrance to using software. This issue was being addressed in the late 1990s by the installation of "intranets", internal college-based networks which used the same hypertext-based browser technology as the internet. It is relatively easy with an intranet for teaching staff to convert their learning materials, such as handouts and assignments into a form which can be viewed on screen, reducing photocopying and ensuring that material is always available for students. Butler (1998), in a BECTA case study on the setting up of an intranet at City College Manchester, was optimistic about their use, but points out that there are problems in changing the working culture of the college and that, in 1998, it was only technology-based courses which made much use of these facilities. Butler (1998) also pointed out that part of the problem in most colleges was that most classrooms did not have computers in them, so there was no access to the learning materials, a problem mentioned more specifically by BECTA (1998) – a case study based on Nelson and Colne College. The FEFC (1996) noted that colleges have faced many practical difficulties in setting up networks, such as with communication links between sites. Although the BECTA case studies reported here showed enthusiasm by their authors, they did not reveal much radical implementation of new resources. Butler (1998) pointed out that most of the material placed on the intranet at that time (April 1998) is concerned with administrative matters, a point also made by the BECTA report on South Essex College (BECTA, 1998) . Both however expressed the hope that once the technology infrastructure was in place, it would allow a greater move towards resource-based learning. The 1998 BECTA report on Nelson and Colne College was entitled "Teaching and learning materials for the Intranet", yet still reported a great deal of content which was largely administrative. The report also expressed the hope that learning resources might be produced which could be marketed.

A 1998 BECTA case study on Luton VI Form College entitled "Recording and monitoring student progress to raise achievement." explored the use of a computerised tracking system for recording the progress of A-level students, thus affecting teachers by cutting down on paperwork, marking and other administrative tasks.

By 2006 the use of intranets had evolved into "extranets" which could be accessed from home and these in turn were evolving into virtual learning environments (VLEs) with a high degree of interactivity (BECTA, 2006; Conole *et al.*, 2008). Intranets and extranets allowed students to access learning materials online; VLEs allow true two way communication, with students able to download and upload their work, storing it in their own user area. This can then be monitored and marked by their teachers, and feedback given. The software to manage VLEs can be supplied commercially and will often integrate with the school's or college's management information system (MIS), although there can be difficulties in the interchange of information between different MIS (Gil and Shaw, 2004). An “open-source” (non-proprietary) alternative is also available in the Moodle VLE (Brandl, 2005). VLEs are becoming commonplace in schools and colleges,although on-line learning is still being referred to in the literature as a “relatively recent development” (Spector, 2005 p5). Blass and Davies (2003), in a study establishing a set of criteria with which to judge the effectiveness of e-learning programmes, refer to the growth of interest in e-learning as being rapid. Also by 2006, computerised testing was being actively promoted by UK examination boards for courses which had previously been examined by multiple choice tests (e.g. Key Skills qualifications). Voice recognition has also been piloted as an assessment tool (Jones, 2005).

2.3.3.2 Students and IT resources

Research on student attitudes to greater use of IT resources suggests they are generally positive. Griffith (1988) noted that students felt the use of computers helped them control their learning. Although this paper is twenty years old it indicates one of the elements in the shift, also noted in Grey and Warrender (1995), from teacher-centred to classroom based-learning. In the National Learning Network’s 2004 report, both staff and students reported generally positive attitudes to the use of IT resources. On the other hand, Muilenburg and Berge (2005), in a study of student barriers to on-line learning, noted that student motivation was ranked in the middle of a list of potential barriers to its take-up with social interaction ranked highest and academic skills lowest. However, developments in storage of course material through the use of an intranet has helped this move, as noted by Butler (1998). The 1998 BECTA case study on Ealing Tertiary

College noted that the aim of its project on an on-line “Integrated Learning System” was to:

> Support the college desire to change the culture and delivery methods used in the college. It provides the opportunity to begin to replace conventional face-to-face teaching with on-line delivery.
>
> BECTA (1998)

This hints at possible developments in resource-based learning which depart from educational delivery in the classroom. A 1998 BECTA case study on South East Essex College discussed the introduction of an intranet with links to the Internet:

> A particular feature of the college is its innovative accommodation where all the classrooms have been transformed into large open access learning centres.
>
> BECTA (1998)

However, such developments face the problems noted in other reports, such as that on Nelson and Colne: “insufficient access to suitable machines for all students” (BECTA, 1998). By 2006 this was less of a problem, with BECTA (2006) noting that the ratio of students to internet enabled computers was 1:4.81.

One further aspect of practice which can impact on students and the nature of institutions is external access to college resources. Internal information systems using web server and browser technology use the same technology as the Internet and have been in use since the 1990s to pool resources (Coleman, 1998). The FEFC 1996 Report of the Learning and Technology Committee expressed great hopes for the use of communications technology in flexible and distance education, highlighting this as good practice. However, much of this was a statement of hope rather than current practice at that time (1996) and various BECTA case studies in 1998 suggested that the implementation of such strategies was progressing more slowly than improvements in technology. As has been noted above with regard to the development of VLEs, this had changed by 2006. Rau *et al.* (2008) in a study comparing four alternative communication methods (the use of email, online forums, SMS messaging and not using a digital format), concluded that mobile communication (mobile phones) combined with use of the internet was the best means of improving student motivation. They also noted that using private communication channels avoids pressure on students, unlike face to face means of communication. The use of the internet in the delivery of educational content to students is now so widespread at the university level, that there have been enough studies on the topic for a number of meta analyses to be carried out (e.g. Bernard *et al*., 2004; Sitzmann *et al.,* 2006);Evans (2008) noted that students found podcasts to be more efficient revision tools than other methods, such as written notes. McKinney *et al.* (2009) report that students who used Apple's "iTunes University" system as means of searching and organising podcasts were more successful than those who attended the alternative conventional lectures. However, Liminiou *et al*. (2009), comparing face to face lectures with the online WebCT system found there was no difference in performance.

One other aspect of practice which affects students, as it does teaching staff, is the potential move towards electronic and automated methods of marking and assessment as well as using computer managed learning systems which allow staff to trace students' progress in automated tests. In recent years this has been pushed forward by the exam boards in the interests of efficiency. This is particularly true in the testing of IT Skills. The Edexcel Examinations Board has an active programme of on demand onscreen testing, and the AQA board has also run pilots in electronic testing for the Key Skills qualification in IT. The "DiDA" IT qualifications introduced by Edexcel to replace GCSE and GNVQ IT qualifications from 2005 onwards are also assessed electronically.

2.3.3.3 Colleges and resources

As well as the discussion of new applications of technology above, consideration of developments in resource use by colleges is also necessary. Despite the introduction of intranets and IT based flexible learning resources, there has been a marked tendency for much of the technology to be used to support traditional teaching, for example through use of computers for word-processing in drop-in centres (FEFC, 1996; Gray and Warrender, 1995). The demand for new resources has been created largely by institutions in response to perceived demand from industry (FEFC, 1996): there often being little demand from users for developments which is one of the problems which the "ILT champions" project at East Birmingham College (BECTA, 1998) aimed to address. One of the changes beginning to occur in colleges in the late 1990s was a move away from a focus on the delivery of education in classes towards the production of learning materials. Some colleges expressed the desire to pool resources with others to ensure high quality materials (e.g. City College, Manchester). Butler (1998) and others highlighted the fact that once materials were developed they might prove a useful source of income e.g. Nelson and Colne College (BECTA, 1998). This trend was noticed by the Further Education Development Agency (FEDA) report by Gray and Warrender (1995) which observed that a hindrance to the development of good teaching materials was competition between colleges introduced by incorporation in 1993, although they also noted the quality of materials developed by colleges which had gone into partnership. Spender

(1996) noted the possibility that this trend could be continued on a global scale. This paper, however, refers mainly to higher education and is written from an Australian viewpoint. It also refers to partnerships with private business (Davies, 1996). These trends have now been incorporated into VLE technology (Conole *et al.*, 2008).

As it is the educational institutions which control significant funding decisions it is to them that choices will fall as to how they develop.

2.3.3.4 Choices and alternatives

Having discussed what technology can do and where it might lead, the different possible developments of practice mean that there are alternatives to be considered in an effectiveness study. Gray and Warrender (1995) noted that:

> A prime concern is the emergence of a widening gap between an educational philosophy across the further education sector in favour of independent and flexible learning, guided by student choice, and the practical experience of most students attending FE colleges
>
> (p6)

The authors point out that the most common use of IT resources by students is for word-processing of assignments and that this “offers little in the way of enhanced student-centred, flexible learning or of economies in curriculum delivery” (p6). The authors also noted that the emerging technologies reviewed earlier support a more student-centred approach.

Technologies in current use tend to support one of two approaches for use in education.

- Use of technology to support existing roles and institutions, for instance the resource centres used for word-processing mentioned by Gray and Warrender (1995), while retaining classrooms, teachers and didactic input, albeit supported by materials published on an intranet (e.g. Vogel *et al.*, 2006).
- Use of technology to support alternative institutional models based on flexible and distance learning (Bernard *et al.*, 2004; Sitzman *et al.*, 2006). This draws on the industrial models such as the "just-in-time" concept in which speedy delivery and technologically advanced ordering methods avoid the need to keep a large inventory of stock or parts, allowing them to be deployed when and where they are needed. IT resources have also been used to provide the "just-in-time" delivery of training for industry, as has been pioneered by higher education institutions such as the UK Open University and, for instance, many US and Australian universities (Spender, 1996). In the mid 2000s this trend has continued with the spread of mobile communication technologies which make access to learning available at any time and any place (Evans, 2008; Conole *et al.*, 2008).

In the 1990s, the FEFC acknowledged that there was a choice to be made in the way technology was used (FEFC, 1996) and listed the types of decisions which colleges faced in developing their use of IT, based on issues such as their capabilities and the cost-effectiveness of IT resources. These included:

- the range of courses to be offered;
- the commitment of teaching resources to those courses;

- the extent to which learning programmes can be tailored to meet the needs of individual students;
- the balance of classroom and workshop based teaching to independent student-centred learning;
- the extent to which investment in learning resources, including resource centres and learning technologies, can or should augment, or substitute for expenditure on teaching staff;
- the forms of support students should receive before enrolment while on course and at course completion; and
- the administrative framework needed to ensure efficient and effective programme delivery.

The extent to which the examples of best practice by colleges, outlined above, have been implemented will determine the extent to which these options are available. BECTA (2006) noted that:

> Colleges identified as "late adopters" of ICT and e-learning showed the greatest increases in management interventions such as target setting. By contrast, the most e-enabled colleges appeared to make fewer management interventions than in previous years. However, these latter colleges increased levels of access for learners and achieved wider implementation of e-learning. These findings suggest two things. Firstly, college managers in late adopting colleges are beginning to engage with ICT and e-learning. Secondly, at the e-enabled end of the spectrum, ICT and e-learning become increasingly self-sustaining and require less direct management input.
> (p. 2)

However in all colleges there will be some degree of IT implementation. Once IT implementation has progressed to a sufficient degree to make the options set out by the

FEFC (1996) possible, a study can be carried out to evaluate the effectiveness of that implementation. An overview of the way in which this has been done in the literature is discussed in the next section.

2.4 The effectiveness of IT in education

In the first part of this chapter, definitions of effectiveness in the literature were discussed. In the second part the literature on the use of IT was discussed. The literature on modelling effectiveness is sparse on the issue of the deployment of resources in general and IT in particular. Scheerens *et al.*(2001) notes that a literature search in the first ten volumes of the journal *School Effectiveness and School Improvement* did not reveal any literature on the effectiveness enhancing potential of ICT. A similar search carried out in the subsequent volumes reveals very little, with perhaps Topping and Sanders (2000) and Thompson *et al.* (2006) being exceptions. Topping and Sander's Tennessee Value added Assessment System study took the scores from an online literacy test (LIS) from different schools and aggregated them in a value added analysis. As such it did not really investigate the effectiveness of IT resources as opposed to non-IT resources. Thompson *et al.* (2006) investigated the policy issues surrounding IT in a survey of a professional development programme for educational leaders and an action research programme investigating literacy, IT and educational disadvantage. Both surveys were in an Australian context. This study did address the core issue of the relative effectiveness of resource use, and found that there was insufficient development of IT resources as a means of school improvement and that practice was characterised by different approaches in schools, rather than "top-down" policy. The use of IT resources can be incorporated into Creemer's model of effectiveness (Creemers, 2004) under the "opportunity to learn" heading, although little attention is paid to this in the literature.

Studies on the effectiveness of IT resources have largely taken three forms. Firstly there are case studies describing the application of new technologies and using largely qualitative techniques to appraise their effectiveness, such as interviewing students and evaluating their responses. Secondly there are intervention studies which compare groups using different methods or resources, including the new resource which is of interest and a control group. The evaluation in these cases is usually by a pre-test/ post-test comparison. Thirdly there are meta analyses of multiple intervention studies, which calculate the effect size of each study and use those data points as the starting points of an analysis.

It is worth re-iterating at this stage that the literature of how IT affects learning is not a body of literature which progressively enhances our knowledge of a fixed phenomena. As described in the previous section, the capabilities of IT in education are constantly changing and new capabilities being developed. Thus, when reviewing the literature over time. it is important to bear in mind the context of the stage of development of the IT resources in. Although there has been previous research into a variety of new media as a means of delivering educational content, for example radio in the 1930s and 1940s (Cavanaugh *et al.,* 2004) and television in the 1950s and 1960s (Bernard *et al*., 2006). The use of computers as educational tools only really began in the 1960s (Kulik and Kulik, 1991). The early use of computers was for "programmed instruction" (Kay *et* *al*.,1968). Computers developed through the 1970s and 1980s improving their capabilities, until multimedia and interconnectedness through the internet expanded their potential in the 1990s and 2000s (Johnson and Johnson, 1996; Park, 2009).

Throughout the period outlined above there have been studies of the effects of IT on learning. Clark (1983) is a useful place to start. His review of meta-analyses of interventions studies looked not only at the use of computer aided instruction, but also drew on the earlier body of studies into interventions of other "media" such as television. Meta analyses calculate the effect size of a larger number of intervention studies and use these as data points for an analysis. The effect sizes are typically calculated by taking the mean score (derived using pre-test/post test methods) of the experimental group minus the mean score of the control group divided by the standard deviation of all the students in the survey (Lou *et al.*, 2001). Clarke found that the evidence which he reviewed at that time (1983) showed there was nothing about the media of delivery which influenced student achievement, but was rather a means of delivering content. It was the content which was important. Clark also noted that new media may have an effect on their learning, merely because of the novelty of the approach, and the associated enthusiasm of the teacher. Since that time the majority of meta-analyses have contradicted Clarke's findings, and this may be due to Clark's research drawing on old studies which included non-interactive media rather than concentrating on IT resources. Kulik and Kulik (1991) in a meta analysis of 254 controlled evaluations studies found that the effects of computer based instruction were positive. These studies ranged in their coverage from kindergarten to adult students, and the effect size was larger in intervention studies and those studies which were published. Their 1991 study largely confirmed the findings of their 1987 study (Kulik and Kulik, 1987), which drew on studies from an era contemporaneous with the era Clark (1983) was reporting. Khalili and Shashaani (1994), drawing on 36 studies from the period 1988 to 1992 also found that the effects of computer aided instruction were positive, and that effect sizes were higher where different teachers taught the control and the experimental group, suggesting a teacher effect on the relationship between the resources used and the effect on learning. The period in which this last study was conducted was prior to the impact of multi-media computing and the internet. Fletcher Flynn and Gravatt (1995) in their meta analysis concluded that the positive relationship between IT and learning was not proven, but noted that the studies they investigated were mostly prior to the introduction of multi-media techniques. Since the introduction of these enhanced IT capabilities, meta analyses have mostly concurred as to the positive effects of IT resources. Lou *et al.* (2001), in a meta analysis of 122 studies on group learning as opposed to individual learning using IT resources found that on average small group learning was more effective than individual learning, and that there was a positive relationship between technology and this effectiveness. Process factors noted in their study as accounting for variability in achievement included group work experience, type of program, subject and relative ability level (Lou *et al.*, 2001, p. 477). Höffler and Leutner (2007) in a meta analysis covering 26 studies comparing animation (i.e. multimedia) with static pictures found the animation had the greater effect. Their analysis revealed that animations brought greater benefits when procedural-motor knowledge is requested rather than problem-solving knowledge or declarative knowledge (Höffler and Leutner, 2007 p. 734). Vogel *et al.*(2006) in a meta analysis of studies of the effects of gaming and simulation on learning, found that these aspects of IT demonstrated positive effects. Liao (2007) in a meta analysis of 52 studies on the effectiveness of IT resources over traditional instruction in Taiwan found that computer aided instruction showed a greater effect, and claimed that their analysis disproved Clarke's assertion that there were no learning benefits from media. In contrast, however, Cavenaugh *et al.*(2004) in a meta analysis of 116 studies comparing web-delivered distance education with conventional instruction found no clear evidence that one means was more effective than the other. Sitzmann *et al.* (2006), in a meta analysis of studies comparing web-based instruction with classroom, instruction found the relative effect difference was negligible. Their study suggested that web based instruction was more effective than classroom instruction in teaching declarative knowledge except where the same instructional methods were used for both, but that the two delivery media were equally effective for teaching procedural knowledge. This concurred with Clarke's assertion (Clarke, 1983) that content was more important than the medium. The picture gleaned from an overview of meta-analyses of the effects of IT on learning suggests, overall, that there is a positive benefit to be gained from IT, although this is not unequivocal.

Turning from meta analyses to smaller scale studies which investigate the effects of IT on learning using either intervention methods or case study methods, also reveals an equivocal picture. Levin *et al*. (1984), studying four "interventions" into education, measured effectiveness by "educational gain"; a figure representing the proportion of one year's anticipated improvement, worked out by using an input/output test. The Levin study included "computer-assisted learning" as one of the interventions. The other interventions with which this was compared were: cross-age tutoring, reduced class size and a longer school day. The Levin study compared whole classes which were using the same method, the IT component being the directed use of learning programs on computers in the classroom. The study looked at effectiveness as part of a cost-effectiveness analysis and placed the IT component second behind cross-age tutoring as the most cost-effective intervention. Many studies, such as such as Segers *et al*. (2004), rely on a comparison of pre-test and post-test scores to evaluate effectiveness. Ecalle *et al.* (2009), in a study investigating the effectiveness of computer aided learning in developing literacy skills, used a pre-test, post test methods in an intervention study and found that the experimental group using computer aided learning outperformed the control group. The authors did not, however, offer much by way of commentary as to why this might be the case. Park *et al.* (2009) in an intervention study which investigated the impact of the use of computer simulations found that for students with high prior knowledge, high interactive stimulation was associated with increased comprehension and for students with low prior knowledge, low interactive stimulation was not associated with higher comprehension, suggesting that IT resources of this type are useful in re-enforcing existing knowledge. Papastergiou (2009) in a study of the learning effectiveness and motivational appeal of computer games, using a intervention with two groups of school age students, one using games, the other not, found that group learning was more effective in the group which used games. It should be noted, however, that this study was carried out within the IT curriculum and which may have influenced the result - students who are good at IT may do better using IT resources to study; this was not effectively discussed in the paper. The study also found that there were gender differences with male students engaging more effectively with the method, although they did not show any noticeably increased performance. Limniou *et al.* (2009) in a study comparing web and face to face instruction amongst university students found that students' web based interaction was more effective than face to face interaction. However, it should be noted that the experimental and control groups were in different countries (the UK and Greece respectively), and the study did not discuss the potential impact of this on the results. Connolly (2007) also noted the greater effectiveness of IT resources as opposed to face to face teaching in university students. Liu *et al.* (2009), in a study investigating the acceptance of media, found that course materials which use rich media promote higher acceptance and better concentration. Lopez-Fernandez and Rodriguez-Illera (2009), in a study investigating the use of digital learning portfolios by university students, found that student perceptions of the effectiveness of the method was high but that the impact on their learning was insignificant. McKinney *et al*. (2009) in a study which compared students who followed a course of lectures via podcasts distributed through the iTunes university facility of the Apple iTunes software performed better than those who attended conventional lectures. De Lucia *et al.* (2009), in a study investigating the setting up of a virtual university using the popular online virtual environment "Second Life", found that this appeared to have a positive impact on learning and fostered a sense of belonging. Sun *et al.*(2008) found that web-based virtual science laboratories used amongst school age students were effective and suggested that a qualitative follow up to their study. Muilenburg and Berg (2005) investigated barriers to online learning as a means of exploring the effectiveness of the design of learning materials. These barriers included administrative issues, social interaction, academic skills, technical skills, learner motivation, time and support for studies, costs of and access to the internet and technical problems. Data were obtained on individuals' use through survey responses reporting respondent perceptions of barriers, which included differences in learning style as well as difficulties in adjusting to the technology. The study found that non-IT based factors such as administrative issues, social interaction, academic skills and learner motivation outweighed IT based factors such as technical skills and internet access costs. Fried (2008) in a paper discussing laptop use in class identified their multi-tasking capabilities as being a distraction. A similar approach, based on individual's perceptions as indicated in survey results, was taken by Van Grinsven and Tillema (2006) in comparing different instructional formats. The study compared self-regulated learning in which students' time spent in different activities was under their own control with "traditional" teacher-directed student time, and focused on secondary vocational education. It concluded that self-regulated learning environments were more effective when well designed and teacher behaviours supported the approach. The authors then pointed to the need for further research into this area and methods for evaluating it: "Guidelines are also needed for assessing individual achievements in self-regulated instructional formats" (Van Grinsven and Tillema, 2006, p. 88). Littlejon *et al.*(2008) in a paper discussing the classification of IT resources identify appropriateness of use as a key to effectiveness. Colley and Comber (2003) investigated the use of IT resources at home by school-age students. The study found that gender differences in the use of IT resources had decreased since the early 1990s, but that they still remained, with males using IT resources more, especially in the home. Ballantine *et al.* (2007), in a study on pre-university students use of IT, observed that students made better use of IT resources at home than at school despite the increasing provision of resources at school; however, they cautioned that students often overestimated their IT skills when working at home and questioned its use as the basis for measuring effectiveness. Wittwer and Senkbeil (2007) in a study which investigated the relationship between students use of IT resources at home and at school found that there was no link between use of a computer at home and performance in maths, unless that use was appropriately targeted. The study acknowledged the difficulties in measuring how students use IT resources at home. Nævdal (2007) noted that although students who use a computer at home for more than two hours a day achieved higher scores in the study of English - a foreign language for the Norwegian students in the study – this effect was much more marked in girls than boys. He also noted that there was a peak in this effectiveness at two hours a day. As well as these intervention studies there are case studies, such as Evans (2008), which evaluated the effectiveness of resource use ("podcasting", in the Evans study) without reference to external outcomes, relying on a survey of student perceptions of the intervention. Others studies such as Grabe and Christopherson (2008), which investigated a similar field - a study of effectiveness of different forms of online resources in which text-based resources were found more effective than audio recordings - used output measures (exam results) to evaluate effectiveness, albeit from a largely descriptive standpoint. Cox and Marshall (2008) note that the study of the effects of IT on learning has not led to an unequivocal picture, and identifies the lack of large scale longitudinal analyses which might improve this.

The literature on the relationship between IT resources and effective learning does not give an unambiguous picture. Of the three types of literature discussed above, the school effectiveness literature is the sparsest, providing only hints that the issue of the effectiveness of IT resource use is a field for further research. Intervention studies provide many instances where the use of an IT resource has been effective and some where it has not. These studies are useful in identifying whether the use of a particular resource is effective, although the speed at which the technology develops means that the conclusions from such studies have a limited currency. Interventions studies which attempt to identify the attributes of the technology or its application can help to provide a greater insight in this changing field. The meta-analytical approach gives a better idea of the effectiveness of IT resources from a broad perspective. General themes which emerge from the literature on this field are that effectiveness may be associated with enhanced capability in the technology, particularly multi-media capabilities and increases in connectedness and portability. In addition, the literature identifies the issue that the technology's suitability for many different tasks may be a potential distraction. The relationship between IT use and performance may be affected by this distraction particularly when the users of the resource are furthest from supervision. The technology appears to be effective when students are kept on task. A further theme which emerges from the literature is that student perceptions of the effectiveness of the IT resource may be influenced by the novelty of the technology and other attributes which make it attractive to use. These themes need to be borne in mind in the discussion of the study reported in this thesis.

This present study aims to explore a method of assessing the effectiveness of IT resources which can be used by practitioners and applied to a variety or resources. In this exploration of individual time data analysis, the focus is on IT resources generally. Data can be collected on individual IT resources and aggregated as appropriate. It is hoped that the study will provide a contribution to the field of knowledge on the effectiveness of the use of IT resources, as well as exploring the method. The next section explores the specific research questions used in this study.

2.5 Establishing research questions

2.5.1 Introduction

The previous sections of this chapter have aimed to establish that effectiveness studies are tools which can be used for improving educational delivery and informing choices about resource use. Their main thrust since Rutter *et al.* (1979) has been to identify those processes within the education system which can lead to the achievement of educational aims. Over the same period, technology has emerged with the potential to change radically the way in which education is delivered, both at the institutional level and directly with students. Whereas formerly, contact between the institution and the student was in the classroom, technology now has the potential to render the centralised location of this interaction unnecessary. The range of methods for delivering education is becoming more flexible, although the internal organisation of educational institutions is still progressing towards a full implementation of the new delivery methods made possible by the new technology.

The new flexible organisation of education which is made possible by these advances creates new challenges for the implementation of effectiveness studies. Often effectiveness studies have taken place at the institutional level rather than on the course or student level, focusing on interventions and changes in organisational management within those institutions. In order to be able to carry out an effectiveness study in institutions where delivery has been made more flexible by the introduction of technology, methodologies need to be developed which concentrate on building up a data set from the student level upwards, enabling account to be taken of different ways and groupings in which individual students participate in education. The main focus of this study, therefore, is to explore a possible approach to that methodology – individual time-data analysis - details of which are set out in the next chapter.

A set of research questions need to be developed to explore how an effectiveness study can be carried out on a heterogeneous group of students who are participating in an education system which is potentially flexible at the point of use. These research questions should allow us to explore the features of the education system which have the closest interrelationships with the achievement of aims. The particular focus of this study is the relationship between the use of IT and non-IT resources and performance, and the research questions developed below concentrate, therefore, on the differing use made of these resources, both IT and non-IT, which are provided by a college. In addition, the study also looks at students' access to IT resources at home so that the effects of this can also be analysed.

In an effectiveness study it is important to establish the aims, the achievement of which will determine effectiveness. Once this has been done the study can establish whether IT and non-IT alternatives are available in achieving these aims and how this is to be measured, so that comparisons can be made.

2.5.2 What are the aims of colleges?

Colleges have a wide variety of different educational aims at many different levels. The following list is compiled from a survey of the literature on institutional aims from the FEFC (1993) and incorporating the aims listed by Sammons *et al.* (1995), and applications of the Creemers model of effectivness (Creemers, 1994), e.g. De Hong (2004).

- provide experts from whom students can learn
- provide resources from which students can learn (i.e "learning opportunities" from Creemers, 2004)
- provide a learning environment in which students can reach their full potential
- provide social interaction for students to promote their social development
- prepare students for external assessment
- to provide a curriculum in which a student can reach their full potential
- to build on students' prior learning and experience in the wider community

These aims incorporate inputs to the educational process such as building on their prior learning and experience; processes such as providing a learning environment and outputs such as external assessment scores. The means by which these aims are achieved are discussed below.

2.5.3 How are these aims achieved?

The aims of a college can be achieved through the use of IT or other resources in a variety of ways and the following discussion is based on my own observations, examples from the FEFC survey (FEFC, 1996) and comments made in Gray and Warrender (1995). The potential for achieving the aims listed above may also be broken down into methods by which they can be achieved and who is responsible for their implementation. An integral part of any assessment of whether the aims of a college have been met is to establish whether the achievement of the aims is measurable. The achievement of some aims may simply be measurable in quantitative terms, but for other aims a qualitative assessment may need to be made. It is often easier to measure inputs and outputs, which may have an associated scoring system, such as with external assessments than processes which can be harder to quantify. Where the achievement of aims is based on qualitative criteria and where the assessor is not independent of the process being assessed, objectivity in any assessment of whether aims have been achieved may be compromised. In the discussion below, there will be consideration of whether the aims to be assessed are measurable.

2.5.3.1 Experts

The staff selection and appointment processes of a college provides experts from whom a student can learn through their choice of IT resources and the curricular content delivered via those resources. The achievement of this aim is measurable before any learning takes place by looking at the qualifications of staff in their subject area and their teaching skill. The prior qualifications and experience of staff is an input into the education system and their use of them in teaching may be considered an educational process. An assessment can be based on criteria with clear parameters; for example by establishing whether a teacher delivering the curriculum has an IT qualification of a particular standard? In this study, which emphasises the relationship between students' performance and their use of IT resources, it was felt that an investigation of the relationship between teacher qualifications and the performance of students was outside the scope of the study. Subsequent studies might choose to try to incorporate teachers' qualifications as a variable in the analysis, but should be aware of the dangers in attributing too much variance in performance to the teacher's qualifications, when a sample of several hundred students might only have a few teachers. A study which aims to investigate the relationship between a teacher variable and student performance may need a sample of several hundred teachers and, therefore, record the performance of several thousand students.

2.5.3.2 Resources

A college will provide both IT and non-IT resources for students to use in their learning. These resources may be provided by the college for use directly by teaching staff in scheduled contact time or for use by students in their own college-based research time. Students may have access to resources which can be used for learning outside college time, for instance having a computer at home, or access to resources in part-time work. Also, colleges may provide access to other learning resources provided by other organisations and institutions, such as through a partnership with industry where a college provides students with the opportunity to apply their learning in the workplace. A practitioner may want to discover how effective the use of these resources are, as well as analysing different aspects of the resources such as what the computers are used for, for example: computer use can be broken into categories such as word-processing or use of the Internet. A practitioner may also wish to distinguish between resources provided by the institution and resources provided elsewhere, for instance by the student or in a student placement. Although the process of using resources can be measured in terms of the time spent in using those resources, the effects of using the resources to be investigated are only measurable after the event by analysing performance figures against a breakdown of the resources used. The method used in this study: IDTA, attempts to investigate the effectiveness of the process of resource use by analysing the relationship between resource use and performance in terms of value added scores, which are derived from easily measurable inputs and outputs. The research questions which might be asked to determine the effectiveness of IT in achieving this aim are set out below.

Research Question 1

Does engagement in IT based activities have a discernable interrelationship with improved performance by students?

This is testable by a correlation analysis between value added performance and use of IT resources. It can look at the whole package of policies and practices or at individual resources and type of use to examine whether high use of IT is associated with better performance .

As well as investigating the relationship between resource use and performance, a practitioner may also need to distinguish other factors which can be associated with high resource use. For instance, a student who appears to makes heavy use of a particular facility, such as a student who spends a lot of their time in the library, may also spend a lot of time engaged in other activities. It may well be that they do not spend proportionally more time involved in a particular activity. In order to distinguish a particular activity from "hard work" an analysis of the relationship between the relative periods of time spent in different activities and performance is needed. In relation to IT this leads on to the second research question.

Research Question 2

Can the interrelationship between engagement in IT based activities and performance be distinguished from the general hard work factor demonstrated by greater engagement in all activities?

Any performance increases associated with the "time spent" rather than the "IT" part of "time spent in IT based activities" need to be isolated so that a more accurate picture of the relationship between the use of IT resources and performance can be established.

2.5.3.3 Learning environment

The provision of a learning environment in which a student can reach their full potential may be achieved through processes such as cultivating a college culture and ethos which fosters learning, as well as practical organisational matters such as time-tabling, choice of curriculum, pastoral care, offering a balance of educational resources (for instance staffing, library etc.) and providing resources which are user-friendly, supported by training in using the resources. These processes are difficult to measure; the effects of the learning environment can be measured after the event by reference to results but it is difficult to isolate the effects of the environment from the effects of, for example, the resources provided. The emphasis of this study is on the relationship between individual student performance and their resource use. The study aims to explore this relationship with tools which are usable by practitioners. Data could be gathered. on students' feelings about the impact of the learning environment on his or her performance however, it was felt that it would be difficult to construct a simple analytical model, usable by practitioners, which included both this kind of subjective data and the data gathered on performance and the time taken in using these resources. As a consequence of this no research questions have been be formulated to establish the achievement of this aim which are within the scope of this study.

2.5.3.4 Social interaction

A college can foster this process by providing resources which promote students' social development and by creating an ethos which encourages social activity, such as college-organised sporting activities and clubs. It is doubtful that IT resources can assist with these although email might help students interact with others.

Measuring this social interaction is challenging. One approach might be to measure in terms of success or failure within very narrow parameters e.g. "did the technology help to provide international contacts?" (yes or no), "was this greater than by non-IT resources e.g. a letter?" (a comparison of number of contacts). These do not, however, measure the wider social effects of the use of email. It is possible, however, to track how a student's attitude to other cultures changes through interviews over a period of time but again, this approach was deemed to be beyond the scope of this study and no research questions were formulated to establish the achievement of this aim.

2.5.3.5 External assessment

The effectiveness of an institution in preparing a student for assessment can be judged from two perspectives. The first, objectively, is to look at performance figures or value added performance figures which measure student success, accounting for their own abilities. The alternative is to look at student satisfaction. This could be by an analysis of the results of a survey or of interviews. This study aims at providing tools for practitioners when they are required, for instance, to justify resource applications, and the emphasis is on those output measures which education managers commonly rely on, such as analysis of raw or value added results. An assessment of whether the institution's educational aims have been achieved will be incorporated into the analysis on the effectiveness of resources using performance figures as a variable. No separate research question, therefore, directly arises from an evaluation of how well the institution has prepared its students for external exams

Curriculum

The question of what a student's full potential is can involve a complex discussion of many subjective factors. However for the purpose of this study, an objective measure of the student's potential is incorporated into the value added measure used. Testing or prior achievement can establish a student's potential which can suggest a likely performance outcome (using a regression line of previous student performance). A group of students' actual performance can be compared against their potential to arrive at a value added residual (see the next chapter for a fuller discussion on value added analyses). This element of the college aim is, therefore, incorporated into the performance variables. A college can also achieve this aim by providing a choice of curriculum which makes most effective use of the resources provided. This can be investigated by comparing performance across subjects. The research question which may be used to establish the effectiveness of the college's achievement of this aim is set out below.

Research Question 3

Is the relationship between participation in IT activities and performance affected by choice of subject?

If a college provides resources to be used for all curriculum areas and if those resources are being used more effectively by some subjects than others, then this has implications both for the provision of resources and the choice of curriculum.

2.5.3.6 Prior learning

Colleges can build on students' prior achievements at school or elsewhere and out in the community where they may have had employment experience. The effectiveness of their achievement of this aim can be investigated by addressing the following two research questions.

Research Question 4

Is the relationship between participation in IT activities and performance affected by previous experience of using IT resources?

Research Question 5

Is the relationship between participation in IT activities and performance affected by access to a computer outside college?

The degree to which the process of IT use affects performance may be due to input factors beyond the control of the college, and these factors will therefore need incorporating into the analysis.

2.5.3.7 Other factors

There may also be a variety of other factors involved in the effectiveness of the provision of resources by the college which need to be accounted for, such as gender and ethnicity. These are inputs on which the education process works. These can be covered by further research questions.

Research Question 6

What is the relationship between student gender and performance?

Research Question 7

What is the relationship between student ethnicity and performance?

2.5.4 Summary of research questions for the study

The research questions listed above, together with their parameters, are summarised in Table 2-1 below. The first question is the key overarching question; the others aiming to isolate the effects of other factors on the relationship between performance and use of IT resources.

Table 2-1: Research questions

<table>
<tr><th>Educational Aim</th><th>Question</th><th>Relation to effectiveness/resource use</th><th>Evidence</th></tr>
<tr><td rowspan="2">Aims in educational processes:

To provide resources to create a positive learning environment</td><td>1) Does engagement in IT based activities have a discernable interrelationship with improved performance by students?</td><td>A summary of the finding of the other questions: does the whole package of policies and practices examined reveal that a higher degree of IT use is more effective than low use.</td><td>A correlational comparison between performance value added and use of IT.</td></tr>
<tr><td>2) Can the interrelationship between engagement in IT based activities and performance be distinguished from the general hard work factor demonstrated by greater engagement in all activities?</td><td>The need to isolate the performance increases attributable to the “time spent” rather than the “IT” part of “time spent in “IT based activities”</td><td rowspan="6">As above, broken down by categories</td></tr>
<tr><td>Aims in educational outputs:

To provide a curriculum in which a student can reach their full potential</td><td>3) Is the relationship between participation in IT activities and performance affected by choice of subject?</td><td>Some subjects may have a greater IT use requirement</td></tr>
<tr><td rowspan="2">Aims which account for educational inputs:

To build on students’ prior learning and on students’ experience in the wider community</td><td>4) Is the relationship between participation in IT activities and performance affected by previous experience of using IT resources?</td><td rowspan="4">The degree to which IT use affects performance may be due to factors beyond the control of the college.</td></tr>
<tr><td>5) Is the relationship between participation in IT activities and performance affected by access to a computer outside college?</td></tr>
<tr><td rowspan="2">Other factors</td><td>6) What is the relationship between student gender and performance?</td></tr>
<tr><td>7) What is the relationship between student ethnicity and performance?</td></tr>
<tr><td colspan="4">There may be other factors under this category, such as age or social background, which may influence the relationship between performance and the use of IT resources. Age is unlikely to be a factor if the sample selected is from a population who are largely of the same age group e.g. the 16-19 age group which is a typical population in FE.</td></tr>
</table>

3 METHODOLOGY

3.1 Methodological background

3.1.1 Introduction

The history of educational research has seen the development of three distinct paradigms: positivist or normative; interpretive (sometimes called constructivist or phenomenological) and a critical or emancipatory approach (Guba and Lincoln, 1994). Each of these has a different view on the issues of ontology, epistemology, methodology and data collection, and can be seen as forming a series of dimensions into which a study's methodology can be placed (Burrell and Morgan, 1979).

The ontological dimension is determined by the form and nature of reality (Guba and Lincoln, 1994). On the one hand there is the view that there is only one objective reality which the researcher can observe. Differences are attributable to the observer rather than the unchanging reality. On the other hand the view can be taken that differences in the experience of reality are attributable to differences in the nature of reality. The ontological view taken has an impact on the role of the observer. If an ontological view that there is a single reality is taken, then the observer is impartial and factors internal to the observer, while they may affect the observer's ability to observe correctly, have no bearing on the concrete reality which is being observed. If an ontological view that there are multiple realities is taken, then those internal factors may have a hand in defining the reality which is observed (Corbetta, 2003). This is closely linked to the question of epistemology, which concerns the relationship between the knower and what is to be known (Guba and Lincoln, 1994) that is, on the validation of knowledge. If the ontological view of a single reality is taken then knowledge has to be, and can be, validated by proofs which are independent of the observer. If, however, a multi-reality ontological approach is taken, then the validation of any knowledge of that reality is more concerned with the observer's interpretation of experience rather than reporting an objective phenomenon. The methodological dimension concerns the theoretical analysis of the methods and techniques available to investigate the subject being studied. In general and simplistic terms, the methods available split into quantitative methods which look to numerical and statistical analysis of observed phenomena to test hypothesised explanations of reality or realities, and qualitative methodologies which use mainly descriptive methods to characterise them and the relationships between them. These methods can be applied across the ontological and epistemological dimensions; however studies with a multiple reality ontology have tended to favour qualitative methods, and those with a single reality ontology, quantitative (Gorman and Clayton, 1997).

The three paradigms mentioned above evolved in historical reaction to that which went before. The Renaissance development of "a posteriori" scientific method was a reaction to reasoning by "a priori" logic alone, which had characterised the Classical and Mediaeval world-view (Cohen *et al.*, 2000; Lewis, 1964). The empiricism of this scientific method was first applied to the natural sciences. When the social sciences developed in the nineteenth century, this paradigm was applied to new fields. This paradigm, in educational research, is the positivist or normative approach. Ontologically, the positivist paradigm takes the view that there is a single reality in the world which can be observed. Epistemologically this reality is objective and its validity is independent of the observer (Pickard and Dixon, 2004). Both quantitative and qualitative methodologies can be applied with this paradigm, although care must be taken to ensure observer impartiality especially in the use of qualitative methods, in which it is harder to distinguish the observer's interpretations from their observations. When empirical methods are applied to the natural sciences, then the observer can stand outside the situation which is being observed. It is a true subject-object relationship. However, when the thing being observed is human behaviour and activity, as is the case in general across the social sciences, then it can be argued that a human observer can never observe humanity from outside humanity. In social sciences the relationship is a subject-subject relationship (Giddens, 1976 – cited in Cohen *et al.*, 2000). In acknowledgement of this an "interpretive" paradigm has developed. This paradigm provides, therefore, for a number of versions of reality, depending on the context of the observer and the observed within the same interacting circles of the social and cultural milieu. There is an acknowledgement that the interaction between the researcher and the participant helps to define the reality. Part of the shift to the view that there can be many versions of social reality is the acknowledgement that a single reality model incorporates societal power structures. A researcher working in the positivist paradigm, by observing a single reality which contains within it existing power structures, can be seen as validating those power structures. A Kuhnian "paradigm shift" (Kuhn, 1962 – cited in Cohen *et al.*, 2000) to a multi-reality interpretive paradigm may bring about an understanding that such power structures exist, but does nothing to "emancipate" those who are disempowered by them.

For this to happen there has to be a shift to a third paradigm, where the researcher is no longer just an observer, but seeks to change the reality, to “emancipate” the disempowered (Oliver, 1992; Barnes 2001). This is the “emancipatory” or “critical” paradigm. This last paradigm can be said to incorporate elements of the other two. Habermas (1972 – cited in Cohen *et al.*, 2000), an early proponent of this approach, proposed a categorisation of research into technical (positivist) approaches which involve prediction and control of reality, practical (interpretive) approaches which involve understanding reality and finally an emancipatory approach which seeks to change reality.

This study aims to explore a model for evaluating the effectiveness of using particular resources in education. A model could be created within each of the paradigms described above. A positivist approach could be used which would describe the reality of resource use within a given situation. This reality is characterised by rules which can be generalised from the specific in order to, for instance, seek causes for behaviour and allow for predictions of that behaviour. Choices and assumptions would need to be made in defining concepts such as resource use and performance which would need to be consistently applied throughout the study so that groupings could be validly compared, and conclusions drawn about the described reality. An example would be a study which looked at how the use of computer resources affects performance. Hypotheses would need to be produced which could be tested through analysis of gathered data of IT use and performance.. Such a study would lead to a confirmation or rejection of the hypothesis which would allow the researcher to conclude that either “The use of IT resources is associated with improved performance", "The use of IT resources is associated with diminished performance", or "The use of IT resources has no association with performance". Any such answer may be qualified by further analysis as to other factors.

The realities described by an interpretive approach would focus on understanding meanings and actions involved in the use of resources. In a study of resource use concepts such as use of resources and performance would be interpreted not by objective standards, but by reference to how the people involved in the study saw them. A study of IT use in education within this paradigm might involve an investigation into what the students' goals were, how they felt they had performed against those goals, and whether they felt that the IT resource had been a help or hindrance to them. This investigation would build up a picture which may help future practitioners in understanding realities in their college or classroom.

An emancipatory approach to a study of the use of IT resources would first describe the reality or realities of the situation and then would provide opportunities for the participants to alter the existing power relationships implicit in the provision of the IT resources. The ownership and control of the education system can be altered by the nature of the technology. Older teaching resources, such as teachers and classrooms, favoured a centralised approach to the organisation of those resources: the hierarchical organisation of staff and students within one central location. It may be easier to control the direction of students' learning under such centralised facilities. IT resources can also allow for de-centralisation of education by giving students direct access to learning resources by-passing the teacher as the gatekeeper of knowledge. The key feature of IT is the ease with which it can disseminate information. This can be used to free students from centralising influences but can also extend the reach of those centralising influences such as the national curriculum. An emancipatory approach would empower students to use IT resources in new ways.

Each of these three approaches can validly be used in this study. Each could have a practical benefit for teachers, providing them with a greater insight into the reality or realties of the situations they face in their professional lives. All three can lead to improvements in the education available to students. However, this study has adopted a positivist approach for the following reasons. The resourcing of education in the public sector is governed by principles of political accountability. The politicians who control the budget for public services are expected to arrive at policies which deliver "performance" and value for money. In such circumstances measures of performance have to be sufficiently simple for them to be universally understandable and acceptable. Standard measures of performance are, therefore, used, and it is by these that teachers, schools/colleges and governments are judged. Ontologically, therefore, there is an objective standard by which learning is judged. Epistemologically the picture of reality observed has to be validated by means free from the observer. To be an objective standard it has to be seen as valid from every viewpoint.

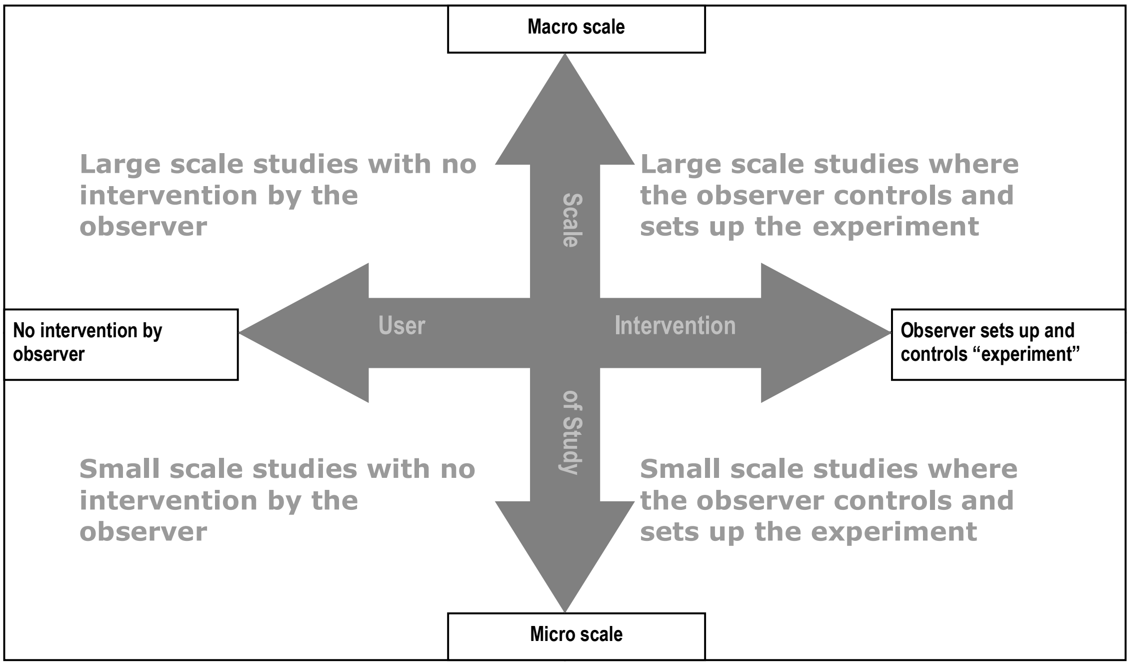
As has been outlined previously, the aim of this study is to develop a methodology for assessing the educational effectiveness of the deployment of resources – in the case of this study IT resources – based on individual student's use of time. A methodology such as this is intended to be accessible by those who are responsible for the effective deployment of resources at the classroom level such as teachers and faculty managers. Those who are required to demonstrate the effectiveness of resources at this level may find that a positivist standpoint, which uses quantitative methods, capable of presenting clear statistical "proofs", provides a concise solution. A qualitative approach might provide more detailed information, but it would require a greater degree of explanatory elaboration.

3.1.2 Previous methodologies

In establishing a method by which practitioners can demonstrate educational effectiveness in the field, adaptability and practicality are important factors. Two key features of the method are that it must be scaleable and easy to implement. A model which can be applied across a range of scales of study from the individual student level through classroom, school, local authority level upwards is better in that it requires less adaptation to new circumstances. A practitioner in the field will benefit from a methodological model which can be applied to their circumstances without complicated adaptation. A further factor is the ease of implementation. A model which can be used for evaluation without changes to practice requires less of a time-commitment from busy practitioners and allows students to carry on without potentially disruptive changes.

In establishing this method, earlier studies can be investigated and mapped against the two spectra: scale and level of intervention. I have developed a graphical representation of this in the Figure 3-1 below.

Figure 3-1: The intersecting spectra describing educational effectiveness methodologies



The scale spectrum ranges from studies where the investigations provide international comparisons, to studies in which the focus is on the classroom or individual student level. On the larger scale end of the spectrum are studies such as Neilson and Tatto (1991) which compared distance learning in teacher education in two developing countries and provide useful evidence of the types of factors which make distance education more effective or cost-effective, other examples include Kyriakides and Chalambous (2005) which discussed multi-level modelling techniques in international studies,. These studies are usually quantitative and are often an aggregation of the measures taken at a smaller scale (such as the output from one course against another) The danger in such large scale studies is that the process of aggregation obscures processes and differences on a smaller scale. For instance, one country's education system might appear to produce better performance by comparison with another, but this might obscure pockets of effective practice in the poorer performing country and pockets of ineffectiveness in the better performing country. These issues have been dealt with in more recent years though the use of multi-level modelling techniques.

At the other end of the spectrum there are studies which focus on the micro level, for instance, studies of individuals or class-groups such as Spector (2005) or McKinney *et al.* (2009). Studies such as these may employ intervention study techniques, looking at student use of IT resources on an individual student level or by groups, comparing pre and post test scores. However some studies at the micro end of the spectrum employ case-study methodologies, for instance, Blass and Davies (2003) who devised a set of criteria to use when evaluating an "e-learning" scheme, such as "the appropriateness of an e-learning strategy, the interaction between the proposed market and the design of an e-learning product, the nature of student-faculty interaction within the e-learning environment and issues of evaluation" (p. 227). At this end of the spectrum qualitative studies become more practical because of the small numbers of students involved and quantitative studies less practical because of issues of sample size.

There is a large volume of research in the middle of this spectrum which focuses on school effectiveness. Studies in the tradition of Rutter *et al.* (1979) seek to ascertain the effect on students of schools as opposed to other factors such as social background. They are useful in that they generate input, process and output measures which can be used in further studies, and which can inform policy. However, they attempt to measure the effectiveness of a whole institution rather than differing methods of delivery within an institution. Thomas (1990), provided a useful guide to the issues raised in a cost-effectiveness analysis, but also compares whole institutions. Also comparing institutions are studies such as Van Houte (2004), which used multiple regression analysis to establish the relationship between gender and performance within a variety of institutions, thus establishing whether gender can be distinguished as a factor.

The other spectrum is that of the degree of intervention by the observer. On the one hand, if a researcher has a theory that a particular educational technique or resource will be more effective, they can set up an experiment or “intervention” to test that hypothesis. This requires a high degree of intervention as, in order to test the intervention, it must be applied to one group, while another carries on without the intervention, acting as a control. These studies are generally positivist and quantitative in their approach and assume that it is possible to compare distinct groups with others. Examples of studies of this type include those by Levin *et al.* (1984) comparing different treatments including computer aided learning or Segers *et al.* (2004), which evaluated the relative advance in story comprehension by kindergarten students in two groups, one which was teacher mediated, where a teacher read a story, and computer mediated, where a story was delivered by computer. At the other end of this spectrum are studies in which the researcher does not intervene in activities, but merely observes them. Studies at this end of the spectrum are often qualitative, for instance Colley and Comber (2003), who used a qualitative investigation to examine the use made by school age students of IT resources at home. They can also be quantitative, for instance Selwyn and Gorard (2003), which avoids the use of a field survey by analysing an existing database of 5885 households.

To be a useful model which can be followed by practitioners, this study needs to be capable of running at a small scale, with minimum intervention in the education process, so as to avoid drawing too heavily on practitioners' scarce time and to avoid disruption to students. Small scale studies lend themselves to qualitative methods, but are difficult to scale up by aggregation. The aim in this study is to establish a model which can be applied across the scaling spectrum. The use of quantitative methods, which allow scaling by aggregation, but still allow for a sufficient sample size, for instance, in a class of twenty students, would be appropriate. The solution explored in this study is to measure effectiveness by looking at individual student activities. Hypotheses can be tested by statistical methods after observation of the activity has taken place and disruption is kept to a minimum. The problems of small sample size can be avoided by designating the sampling unit as an item of activity rather than a student, thus a few students can create a larger number of observations of activities (sampling issues such as these are discussed later in this chapter). A further advantage of the scalable study based on individual student activities is that it can be used in situations where a teacher does not know all the possibilities of how resources such as IT might be used. Once the type of use is recorded it can be logged and added as a category. An example of a methodology of this type, which is based on a study of individual student's activities, is Epstein, *et al.* (1996) who measured the effectiveness of home learning packages for studying English over the summer break by US 9th grade pupils. The study looked at a situation where the learning process was under the control of the students, to the extent that it was undertaken in their own time and using their own resources in their own homes. In such a situation the use to which the learning packages were put had the potential to vary at the student level. Other examples include Nævdal (2007) which investigated the effect of home use of internet resources on the learning of English (a foreign language for the students in the study), and Wittwer and Senkbeil (2007) which investigated the relationship between students' use of IT at home and performance in maths. While not providing a blueprint, studies such as these give pointers to the parameters for a study of the effectiveness of the use of IT where the technology is used to differing degrees and in differing ways by students (see also FEFC, 1996; BECTA, 1998 and DFES, 2005a).

Having discussed the methodology for the study, the methods available now need to be considered.

3.2 Research methods

3.2.1 Background

A course or section of a course may allow students to use IT to varying degrees and teaching methods may also vary. The methods used to evaluate the effectiveness of the course need to take account of the differing ways in which IT is used and the degree to which it is used by measuring individual student use of IT and non-IT resources.

3.2.2 Measurements

The aim of the research questions, which were set out in the previous chapter, was to investigate the relationship between the use of IT resources and the performance of students and to distinguish this from the interrelationships of IT resources use and other factors. In considering the relationship between IT resources and student performance, I need, firstly, to establish whether a comparison can be made between the use and non-use of IT, and secondly, if it can, what measures should be used to compare performance?

3.2.2.1 IT and non-IT use as alternatives

In the literature review six common educational aims of colleges were listed:

- provide experts from whom student can learn
- provide resources from which student can learn
- provide a learning environment in which student can reach their full potential
- provide social interaction for students to promote their social development
- prepare students for external assessment
- provide a curriculum in which a student can reach their full potential

A college can achieve these aims by a variety of means, using both IT and non-IT resources. In evaluating the effectiveness of IT resources, the means of delivery must allow a comparison with non-IT resources, that is the means of delivery must not be exclusively through IT or non-IT resources. Some examples are described below.

Situation	Example of a situation in which this can be achieved
Only IT can be used	**Learning how to use a spreadsheet package** It is possible that the use of spreadsheets could be taught on a purely theoretical level without any hands-on experience, though the effectiveness of this is doubtful.
IT cannot be used	**Learning a physical skill**

	It is debatable whether there is any area where IT cannot enhance the learning process. A physical skill for instance in PE or the performing arts needs hands on experience. IT resources can be used in the delivery of the theoretical background, and might be used in some areas of performing arts (for instance, a computerised display showing whether the right note has been hit in music) however, there remain certain physical skills for which there is as yet no IT-enhanced substitute.
IT can be used amongst other methods	**Researching for an A-level history essay** Material can be found on CD ROMs and on the internet but also in books and periodicals.

This categorisation informs decisions about which subjects were investigated in the study. In order to be able to investigate the relationship between both of IT and non-IT resources and performance, both types of resource must be available to the student. In the case of this study, the survey identified learning aims at the course level, but not in any more detail. As a result of this, even IT courses could be said to use a mix of IT and non-IT resources – IT students still use books and manuals, for instance. However, a subsequent researcher using time data analysis needs to bear in mind the distinction above, if he or she is breaking down resource use in more detail.

3.2.2.2 Individual time data

Students spend varying amounts of time in different activities, and so a simple comparison of two separate groups will not be possible. In the circumstances where use of resources varies at the student level, one method is to ascertain (by the use of a questionnaire) what proportion of their time is spent in using different resources, having broken these down into categories. If the college used monitoring software to log how long students spend using IT resources, this would be of benefit as it would provide accurate data which eliminated any of the potential problems associated with self-reporting. However, this would not pick up data on students' use of time at home (although time using a VLE, for instance, might be logged). Such software was in its early days of development in 1998. In the event, the college surveyed did not use such software either in 1998 or 2006. A questionnaire was devised for this study which divided the possible use of resources by student into categories. These categories were formulated as a result of a survey of the literature on how IT resources are used in colleges (see the literature review) and as a result of my own visits to colleges prior to drafting the questionnaire. The questionnaire was subsequently adapted following it's evaluation by students carried out during the two pilots: one at a college which subsequently dropped out of the study, and one at the college used in the study.

The questionnaire devised for this study asked students to state how much time they spent in each of the subjects they studied. The questionnaire asked:

> In an average weekly period, how many hours do you spend on each of the courses you listed in Question 2?
>
> Please include the time you spend working at home as well as the time you spend working at college.
>
> [See Appendix 2a for the 1998 questionnaire]

The Question 2 referred to above asked the students to identify the courses they studied. When the questionnaire was used in the 2006 survey, the students' courses were inserted automatically in this section of the question using a mail merge from the college's MIS, and the wording was simplified accordingly (see Appendix 2b for the 2006 questionnaire). It was ascertained from the teacher and other college contacts prior to administering the questionnaire, whether the previous week was typical for the college year - that is that there was no disruption due to exams end of term activities etc., as well as checking that the college operated a weekly timetable (as opposed to a two-weekly cycle). In all cases it was a typical week. This enquiry did not cover events which made the week atypical for an individual student. The questionnaire split time by activity and location as shown in the matrix in Table 3-1

Table 3-1: Questionnaire categorisation - time spent for each course using IT resources

	Word-processing	Spreadsheets	Desk top publishing	Information on a CD ROM	Information on the Internet	E-mail	Other (please specify)
Time spent in class:							
Time spent in college outside class (e.g. in the library):							
The time you spend outside college (e.g. at home)							

The same question was asked about non-IT based activities. This was categorised as follows in Table 3-2:

Table 3-2: Questionnaire categorisation - time spent for each course using non-IT resources

	Direct input from teacher	Doing group or individual activities	Using books, periodicals or other paper-based learning materials	Other (please specify)
Time spent in class:				
Time spent in college outside class (e.g. in the library):				
The time you spend outside college (e.g. at home):				
NOTES: "Direct input from the teacher" was explained to the students as indicating times when the teacher was speaking from the front – traditional "didactic" teaching.				

When using survey results it is important to bear in mind the limitations. The data being gathered are not an objective quantification of the amount of time spent by students in different activities, as it would be if this were an intervention study where the activities involved are directly observed by the investigator, but the students' perception of how much time is being taken. In some studies, such as Specter (2005), where students' use of online courses was evaluated, it was possible to get a figure for the amount of time spent in the activity by reviewing online course management records. A study which uses online records needs to be able to log student input rather than merely hours logged into the program, in order to discount time when the student is logged in but not working. This facility was not available on the courses used in this study. To deal with any discrepancy between the actual time a student spends in an activity and the time they report they spend in an activity controls were built into the survey to regulate exaggeration by students. It is often the case in surveys which record the amount of time spent in different activities, that the sum of all the activity times logged exceeds the maximum possible time. A control was made in this survey by dividing the time in different activities proportionally by the total time.

3.2.2.3 Measuring performance

Discussion of performance and the ways in which it can be measured is a key aspect of the study of effectiveness in education. The following section considers the issues involved in selecting a method for measuring performance which is suitable for use in this study. There are many ways to measure the performance of students, and these are incorporated into national qualification schemes such as GCEs in the UK. In order to establish a suitable method of measuring performance - that is of assessing the extent to which learning has taken place - it is necessary to establish why the assessment is necessary. It is then possible to make decisions as to whether the performance indicators available are suitable for assessing performance in the context of this study. There are several possible reasons why a performance indicator may be required. Firstly it may be required in order to establish whether students have reached a particular standard – that is they have reached a certain level of skill competence or learning. A second reason for assessing the performance of students might be for selection purposes. A university might only have a limited number of places available for students to study a particular subject and so may want to select those who are most suited to that study, or an employer might wish to select the most able recruits. Assessment of learning which leads to gradation serves this purpose. Thirdly assessment of the performance of students may be needed to establish the effectiveness of the education process or sub-processes. Here the emphasis will be not on comparing students but on comparing institutions or approaches. The need for a means of assessing performance in this study falls into this latter category. In order to accommodate these differing needs for assessment, a variety of approaches to the assessment of performance have been developed by educators.

If the reason for the assessment of performance is to establish whether students have reached a particular standard, a means of measuring performance is required which might be termed absolute. A set of criteria can be defined against which students' abilities are judged, and they can be deemed either to have reached the standard or competence required or not. This type of assessment of performance has been called "criterion referenced", following on from the work of Glaser (1963). The "criterion referenced" category of assessment of performance more usually involves a student reaching a pass-mark in a test. Using criterion referenced assessment ensures that minimum standards of competence are maintained over time (provided the criteria are the same), However, this type of assessment does not control the number of students achieving the standard and so can cause difficulties for those who wish to use qualifications derived from them as a means of selection.

Where there is a need for performance indicators which can be used in selection there are other forms of assessment which are relative. Assessment may be "norm-referenced" in Glaser's classification (Glaser, 1963). This approach has been used for educational testing since the 1940s (Wikstrom, 2005). In norm-referenced assessment the range of results are plotted against a normal distribution curve (Gregory, 2004), and graded according to percentiles (e.g. the top 10% get a grade A). This provides a better assessment of ranking within a particular cohort, aiding selection but does not guarantee the maintenance of standards, for instance, by providing an adequate guarantee that an A grade one year equates to an A grade the next year, although variations between years may be minimised by the large populations involved in an A level cohort.

In England, GCSE and A-level results are used for both the purposes outlined above – to show an indication of the standard reached by students – sometimes referred to as "curriculum standards" (McGraw *et al.*, 2004 p.1) and to provide gradation between students for selection purposes - "examination standards" (McGraw *et al.* 2004, p.1). This dual purpose means that there is a potential conflict, and the question, "are A levels/GCSEs getting easier?" has been widely debated both in the academic literature and within wider journalistic writing (Stobart, 2000). Investigating this question for QCA, focusing particularly on A levels, McGraw *et al*. (2004, p.iii) concluded that although the English system was not without its problems "no examination system at the school level is better managed" and adequately balances these two competing demands of the examination system, and point out that maintaining standards over time is difficult to carry out when curriculum content necessarily changes. Coe *et al.*(2008) note that although there IS an obligation on awarding bodies to maintain standards over time, there is no explicit mention of the need to maintain standards across subjects. To balance the need for standards and gradation, A levels and GCSEs are graded using a complex combination of quantitative norm referencing and qualitative criterion referencing (Coe *et al.*, 2008; QCA, 2007) which aim to ensure proper gradation while at the same time ensuring consistency from year to year.

Qualifications, for instance GCSEs and A levels in England, are performance indicators which attempt to establish that a student has performed to a certain standard and which can be compared to the performance of other students. They can also be used in comparing the effectiveness of institutions; however, this is problematic because such a judgment assumes that reaching a particular standard by students, whether absolutely or relative to each other, is a meaningful proxy for effectiveness of educational processes. Performance measures based on raw standards do not measure the "distance travelled" by the student in their learning (LSC, 2004). For example, a student who might reasonably be expected to achieve a B grade and then achieves an A grade has performed well against other students nationally, and has achieved better than they expected. A student, who is expected to achieve an E grade and actually achieves a B, has shown a lower achievement standard when compared nationally, but their improvement is much greater. It could be argued that the education system was more effective for the second student than for the first. As a result of this, "value added" measures have been developed to assess the effectiveness of educational processes. The term "value added" derives originally from the study of economics, and refers to the value of a finished commodity over the cost of the raw materials used to produce it, In the context of education, a value added score is a measure of performance against a student's own potential rather than against other students (Mayston, 2006). Using value added scores as a measurement of the effectiveness of an aspect of education allows comparison of the progress of populations of differing ability. With a value added score the measurement of performance is the extent to which a student has achieved his or her potential rather than their assessed performance. The need for value added measures began to be identified in the 1980s, with work such as Gray *et al.*(1986, cited by Mayston, 2006 and Jesson, 2000), and continued into the 1990s, in response to the government's use of raw performance data in comparing schools using "league tables". Value added approaches based on prior attainment began to be developed (e.g. SCAA, 1994; Fitz-gibbon, 1997).

The starting point for most value added methodologies is a prediction of future performance based on prior attainment, using regression lines plotted using ordinary least squares regression based on large datasets (for example a national data set such as all A-levels students in the country). The predicted performance is then subtracted from the actual to give a residual gain (Fitz-Gibbon, 1997). An alternative to regression-based methodologies can be found in non-parametric methods which have been proposed based on the input/output ratio between two actual tests. These methods are discussed further below.

3.2.2.3.1 Regression-based methods

Value added analyses which are based on residual gain techniques involve taking the score from an input test and plotting it against a regression line based on a large national data set, calculated using ordinary least squares methods. A prediction of a possible output score can be made by plotting the student's input score on the regression line off the output score. When the student obtains their actual result it can then be compared against their predicted result using the following formula:

value added score = actual result – predicted result.

If the student has performed better than their prediction, they have a positive value added score, if they have performed worse they have a negative value added.

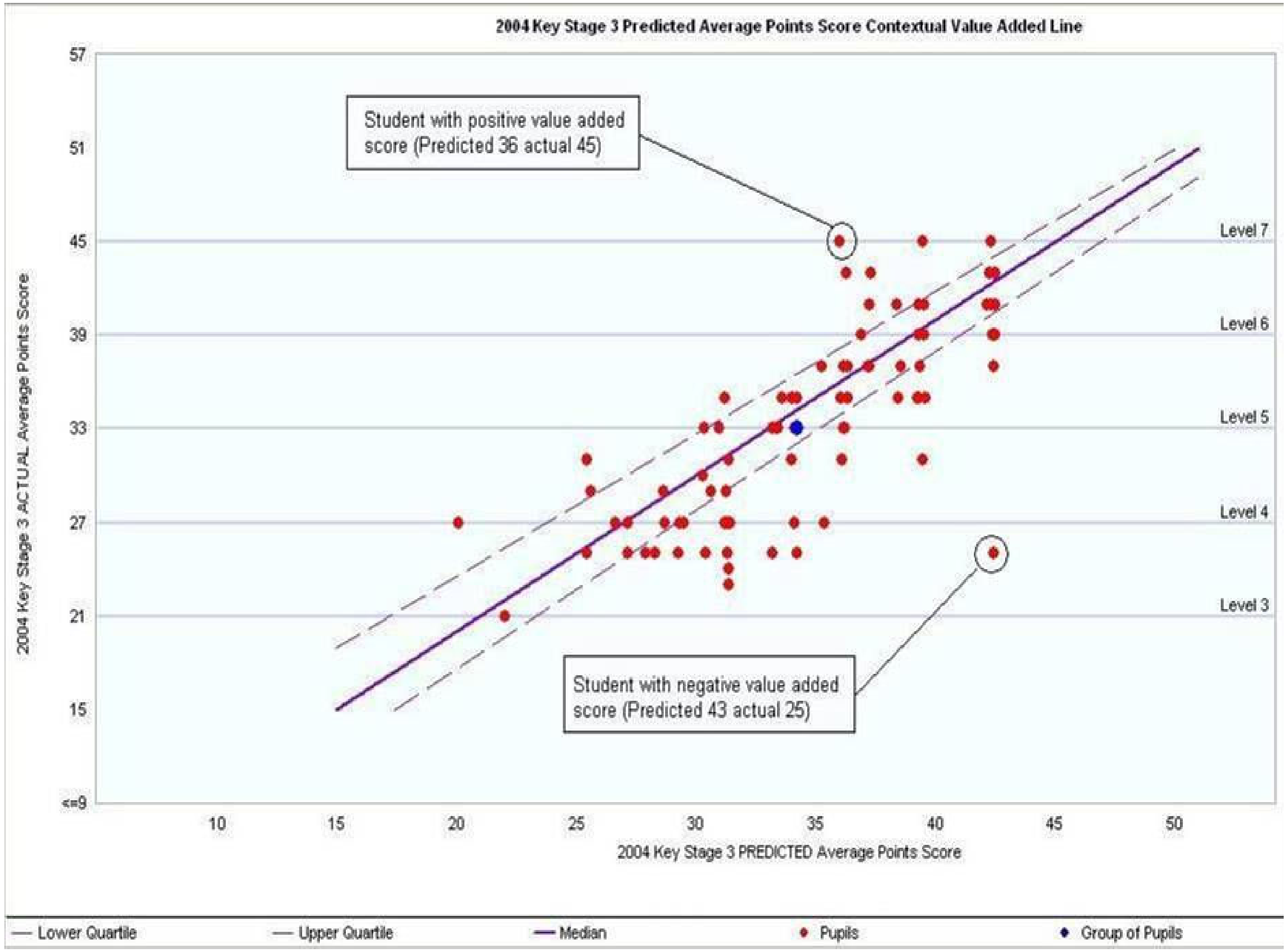
Value added methods based on residual gain show relative performance between groups, rather than the achievement of absolute standards. Such a method can be validly used in a study which seeks to compare two or more groups. The study reported here seeks to compare the performance of students who spend more time using IT resources with those who do not, and so these methods can be validly used in a study such as this.

Schools often use this method erroneously to provide individual predictions for students; however it can be used for groups. In a study such as this, where the proposition being tested is that individual differences in the use of IT resources make a difference in performance, the value added score of those students who make more use of IT can be aggregated to indicate whether this group is performing better than the national data set would predict.

Example of a residual gain method

A student on entering secondary school will have a Key Stage 2 SAT score. This can be plotted on a regression line based on the gain in National Curriculum level points for all students in England and Wales, and a level can be predicted for the end of KS3. At the end KS3, the student takes their KS3 SATs and obtains a score. Their gain in points can be compared against their predicted gain and a value added score obtained (see graph below). If one class shows a value added score consistently below the line, then it can be suggested that there is something about that group which is causing them to under perform. In the example below, the group as a whole indicates slight underperformance, because more of the points are below the mean line and more are below the lower quartile than are above the upper quartile.

Figure 3-2



An example of the prediction comparison value added method. This was produced using the DfES Pupil Achievement Tracker software for schools

3.2.2.3.2 Non-parametric methods

Using ordinary least squares regression makes an assumption that the performance data has a normal distribution. Non-parametric methods have also been proposed as an alternative. These methods are based on a comparison between input and output scores. Such methods have been used for instance, in higher education where the curriculum and qualifications are controlled by institutions rather than national awarding bodies, and so there is no national dataset on which to base a regression analysis. For example, Cowan (1985) suggests measuring educational effectiveness by the use of a gain ratio:

$$\text{Gain ratio} = \frac{\text{post-test score - pre-test score}}{\text{100 - pre-test score}}$$

This method has the advantage that it can be made to produce a single numerical score for each student. Each assessment system may use different grading scales, some numerical, others based on grades. Numerical scores can always be compared, even if they are from different scoring scales; a formula equating the scales can be applied, for instance, by turning the score into a percentage. Grading systems can, and usually are, assigned numerical values so that calculations can also be made using them (e.g. GCSE Point Scores, UCAS Points for A-levels). Mayston (2006) notes that the value added method used in DfES Secondary School Performance Tables 2002 (DfES, 2003), is non-parametric. This method takes advantage of the common points score equivalences of KS2 and KS3 levels in English schools to calculate the student's performance gain in KS3. The value added score of a pupil is arrived at by comparing the pupil's actual KS3 output measure with the median level of the KS3 output measure across the whole country of pupils with the same or similar input measure at KS2 to this pupil (Mayston, 2006 p. 30). This method is non-parametric, because of the non-linear curve of points scores which is a result of the leveling-off in the bottom end of the point score scale. The DfES method can also be applied to measure the gain for students in KS4, even though the point scores for the output of KS3 follow a different scale to the points scores for GCSEs (the measure used at KS4). In this instance the national median capped GCSE points score (i.e. the points for the best 8 scores) is mapped against the national median KS3 scores.

3.2.2.3.3 Multilevel analyses

A further dimension to the use of value added measures is the need for multi-level analyses. In order to clarify the relationships between the variables which may be associated with higher performance, aggregation and disaggregation of the data is needed. Some of the variables related to performance may vary at the pupil level (e.g. gender, social background, prior performance), some may vary at the class level (e.g. the teacher, the subject studied), and some may vary at the institutional level (school effects). In developing methods of establishing value added, this capability needs to be built into the structure of the data gathered, so that any bias linked to aggregation can be identified.

3.2.2.3.4 Multivariate analyses

In the discussion above, the need for performance indicators which measure the value added by the education process, rather than just the output has been made clear. The examples described, however, for both residual gain analyses and non-parametric approaches are simplistic models. Many variables may affect a student's performance, and in recent years the need for value added models which account for these variables has been established. Research over the last twenty years into this area (e.g. Thomas and Mortimore, 1996; Sammons, 1995) has led to the adoption of a contextual value added model to measure school effectiveness. This is the approach now adopted by the DCSF (the UK Government department responsible for education which succeeded to the DfES in the UK). The contextual value added approach takes a residual gain analysis approach and then adjusts the results by taking into account other pupil level variables. An example of this approach from the DCFS Guide to Contextual Value Added Models KS3-4 2008 (DCSF, 2008) is set out below

Table 3-3: The 2008 formula for predicting a pupil's KS4 average point score based on KS3

The contextual value added between the end of KS3 and KS4 for a pupil in English Secondary schools in 2008 can be worked out by the following formula:				
1) Raw value added:	13.101 -0.0153*(KS3 APS squared) +12.15*KS3 APS + 0.500*(KS3 English points - KS3 APS) -0.886*(KS3 maths points - KS3 APS)			
2) In care?	-20.386 (if in care)			
3) Social Background	-33.834*IDACI score			
4) Special Needs	- 13.348 (if School Action) - 36.938 (if Action Plus or Statement)			
5) Late Joiner	- 57.224 (if joined after Sept Y10)			
6) Gender	+ 10.645 (if female)			
7) Age	- 7.379*(age within year where 1 Sept= 1.00, 31 Aug = 0.00)			
8 Ethnicity	Coefficient from the table below:			
	category	coefficient	category	coefficient
	White British	0.000	Pakistani	14.421
	Irish	-0.483	Bangladeshi	16.287
	Traveller of Irish heritage	-38.017	Any other Asian background	19.673
	Gypsy/ Roma	-41.104	Caribbean	14.106
	Any other white background	9.214	Black African	21.805
	White and Black Caribbean	-1.994	Any other black background	13.169
	White and Black African	5.845	Chinese	25.143
	White and Asian	4.622	Any other ethnic group	15.139
	Any other mixed background	4.936	Unclassified ethnic group	-3.269
	Indian	16.211		
9 Free School Meals	**- 16.291 + FSM/ethnicity interaction from table below**			
	Ethnicity category	FSM/ethnicity interaction	category	nteraction
	White British	0.0000	Pakistani	13.3032
	Irish	-2.5622	Bangladeshi	15.7877
	Traveller of Irish heritage	18.1240	Any other Asian background	16.5284
	Gypsy/ Roma	14.2381	Caribbean	14.3137
	Any other white background	12.4430	Black African	17.0664
	White and Black Caribbean	10.1715	Any other black background	11.2465
	White and Black African	21.6886	Chinese	16.1903
	White and Asian	11.3171	Any other ethnic group	20.9649
	Any other mixed background	10.5405	Unclassified ethnic group	3.6222
	Indian	14.4137		
10) Cohort	- 1.844 * cohort KS3 average point score - 4.993 * cohort KS3 APS standard deviation			
NOTES: IDACI = Index of Deprivation Affective Children Index				

The mean of these pupil level calculations, added to 1000 gives an index which is published in the school league tables. It should be noted that despite including other variables, the most powerful variable is still the input score (DFES, 2005c).

3.2.2.3.5 Variations over years

A further aspect to consider is that of variation of performance over years. Value added analyses based on residual gain, as noted above, are measures of relative performance, rather than absolute standards. With the large national datasets involved in producing the regression lines from which the residual gain is calculated, it is not anticipated that there will be large fluctuations between the years. However, it might be anticipated that the combined effects on educational practice of research into school effectiveness might be produce a slow trend upwards in performance over a period of years. This variation needs to be identified and acknowledged when judgments about institutional effectiveness are being made. Any improvement by an institution or department needs to take account of any general national improvement. This will be a factor to consider in studies with a longitudinal aspect.

3.2.2.3.6 Variations between subjects

A further aspect to consider is that there may be variation between the value added in different subjects. There is a strong body of evidence in the literature that some subjects, for instance science, technology, maths and languages are "harder" than others. The research literature starting in the 1970s (Coe *et al.*, 2008 cite Nuttal *et al.*, 1974 and Kelly, 1975 as examples), has largely concurred in this analysis. That some subjects are harder than others is shown by a variety of techniques. These include subject pairs analysis where the results for different subjects are compared for students who are studying the same combinations of subjects, the assumption being that this will reveal differences which are associated with the subject studied rather than being student-based. Other techniques derived from value added analyses are based on regression lines.

Further analyses were based on analyses of variance, and analyses of the difference between a target subject and other subjects. The recent study by Coe *et al.*(2008) showed that there are very strong correlations between the results of analyses using different techniques. In addition to the body of literature which shows that some subjects are harder than others, there is a body of literature starting in the early 1990s with the work of Carol Fitz-gibbon for the CEM centre at Durham University, which suggests that each subject studied needs to be treated separately, with its own regression line for value added purposes because of these differences in difficulty between subjects (Coe *et al.*(2008). Coe *et al.*(2008) also demonstrated that, apart from a "blip" in 2001, there has been consistency in relative difficulty of subjects over the last ten years

3.2.2.3.7 Selecting a method of assessing performance for this study

This study aims to explore methods of assessing the effectiveness of resource use which can be used by practitioners. To assess effectiveness, a performance indicator is needed to compare the output of students who are differentiated by the level to which they use IT resources. For the reasons discussed above, performance indicators, such as raw A level results, measure the standard which a student has reached, either absolutely or relatively, but do not measure the distance they have traveled in the learning process. A study which investigates the effectiveness of resource use is an investigation into the relationship between resource use and the distance travelled by the student. The performance indicators which are required, therefore, are those which measure the "value added". Considering the value added methods discussed above, a simple input/output analysis based on before and after tests, which establishes a gain ratio for the students can easily be applied by practitioners in the field, if there is a suitable one available and provided it can be incorporated into the normal run of assessment and does not create extra work load. For an external investigation, however, such as a PhD study, using an input/output method can be intrusive, requiring either a specifically designed input and output test to be administered with the class or requiring close liaison between the external investigator and the practitioner, which can be time-consuming. A prediction comparison using residual gain analysis techniques can, by contrast, be carried out by the investigator from data held on a college database without any disruption to students. This type of analysis has the advantage that it uses the assessments which are also used in national value added performance figures. The data a college holds on students is also normally available for staff to use in prediction comparisons and it is often something they are required to do by their managers. Residual gain analysis techniques assume that students' test results are normally distributed. This is most often the case, even with the smaller groups of students which a practitioner may wish to investigate, and was the case with the two data collections in this study.

A method was needed to establish a value added performance indicator, at the time when this study commenced in the late 1990s. It is acknowledged that there has been a great deal of refinement of such methods since the original data-collection and analysis in this study, and this may inform future studies which follow the methods used by this study. Several possible methods were identified. The two main methods which are used by colleges in value added analyses are that employed by Greenhead College in Huddersfield (Greenhead College, 2001) or that employed by the CEM centre at Durham University for the ALIS project, which follows the leading work of Carol Fitz-gibbon in this field. The ALIS project's methods are the most sophisticated, taking into account the different regression lines which apply for different subjects. However the ALIS projects' method is a proprietary one to which colleges subscribe and, although information about the regression line may be gleaned from a study of the literature, unless a college subscribes to ALIS, the predictors which are produced are not universally available to practitioners for use in value added analyses. The other method of analysing value added which is commonly used by colleges is also proprietary. This is the ALPS project developed by Greenhead College. This approach is also based on regression lines, but does not distinguish between subjects, and so may be less accurate in distinguishing hard from easy subjects. At the time of investigating the methods to be used in this study, the predictors produced by the ALPS projects were like those from the ALIS project, not universally available. However, from the autumn of 2008, it has been possible to download predictors for a cohort from the ALPS website. This may, therefore inform the choices of subsequent time data analyses by practitioners who require an accessible means of producing a value added performance indicator. Seeking such an accessible means at the start of this project in the late 1990s I chose a simple method described by the DfES in their report added value in further education in Wales (1999) pp. xi – xii. This choice was made because the methods were accessible and also, because it had been used by the DfES, it had an element of "official" sanction about it. The method is set out below:

Step 1: Calculate the input score (at GCSE level)

- apply weightings to each GCSE grade on a scale

  A=7, B=6,........ G=1, U=0

- take English, mathematics and the best five other subjects
- sum their weighted values to obtain the INPUT SCORE

Step 2: Calculate the expected A-level score

- apply the formula linking GCSE grades to expected A-level grade (the regression formula)
- for their study Audit Commission/OHMCI estimated this as being (1.05 times input score) - 29.46
- the resulting figure is the expected A-level score

Step 3: Calculate score achieved

- apply weightings to each A-level grade actually achieved
- use the UCAS weighting scale grade A= 10, grade B= 8,.... grade U = 0

  - sum these weightings for the actual score

Step 4: Calculate the added value

- deduct the expected A-level score from the actual A-level score
- if the student performed better than expected the result will be positive (i.e. greater value was added than would be expected)
- if the student achieved less than expected the figure will be negative.

Notes:

1) This method uses the old UCAS points scale
2) This method uses the old (pre-2004) points system for GCSEs

3) This method uses GCSE scores as inputs and UCAS scores for A-levels as outputs. It is therefore suitable for this study which is based on students at a sixth form college who obtained GCSEs at school and are studying A-levels or equivalents (e.g. Advanced GNVQs or their replacement qualifications). Students who studied other qualifications than GCSEs (input) and A-levels (output) can also be fitted into the method, if their qualification has a points score which can be fitted onto the two points scales identified. In the first data collection (1998 – 2000) a few students' results had to be dropped from the value added calculation because an equivalent points score was not available for their qualification. This was less of an issue in the second data collection (2006- 2007) because in 2004 a new points scale had been devised by the DfES for GCSE with the specific aim of allowing other qualifications to be fitted into the scale. These new qualification's points could then be converted back to the pre-2004 scale. This meant that fewer qualifications needed to be dropped from the value added calculation.

It should be noted that although this is an accessible approach to producing value added performance indicators it does not include multiple input variables and does not account for differences in difficulty between different subjects. This first issue is not as problematic as it might be because multiple variables are considered in the research questions and are accounted for by a statistical analysis which relies on the same raw value added score for consistency. That the method used does not take any account of the differences in difficulty between subjects noted by Coe at al (2008) and others, needs to be borne in mind in discussing any conclusions as to the relationship between the subject studied and performance. It is also acknowledged that any general improvement in national results may change the regression line used in this method. This may affect the value added scores for the second data collection in 2006.

3.2.2.4 Additional student data

Additional data about which courses the students were following was obtained from the time data questionnaire. Further information on the students was also obtained from the data set extracted from the College's MIS system. This included four items:

- Courses studied by the student. The data provided a useful check on the accuracy of the data provided in the student's questionnaire. Often it was found that there was more detail in the data provided by the college MIS than on the questionnaire return, for instance a student might have written "law" as a course on their questionnaire, without indicating a level, but on the MIS data the student was revealed as studying A-level law. As a result of this checking process much of the data logged in the questionnaire could be clarified, although a few records had to be rejected because of a mismatch. The question of rejected data is dealt with in more detail in the descriptive statistics chapters.
- Possession of an IT qualification on entry
- Gender
- Ethnicity

Data on a student's access to a computer outside college was obtained from a supplementary question on the Time Data Questionnaire.

3.2.3 Sampling

With a quantitative survey the selection of the sample is important. The sample needs to be representative of the population and of sufficient size to avoid distortion or bias in the results. To provide valid results, normal sampling criteria need to be applied.

The key issue is the selection of a sample which is representative of the population of which it is part. Ideally a large sample should be used. However the ideal situation is difficult to obtain because of factors such as cost, time and availability of information. Boroughs (1975) comments:

> ... It is manifestly unrealistic to expect that the individual worker will succeed in obtaining anything but a very rough sample ... his experimental conclusions will inevitably be limited in generalisability and he will know sufficient only to understand why this is so and what he can do to minimise it. (p.56)

The sample size of groups selected for an evaluative study in the field may be small, although in relation to the population to be evaluated may be very large. There are circumstances where the sample may equate to the entire population, for instance where a teacher wants to carry out an evaluation of practices in their class. It is therefore important to clarify what is meant by the terminology involved here.

3.2.3.1 Population

This study involved an investigation into the effectiveness of IT in a sixth form college. The population was potentially all students in the college system in England. However, if, as in this study, the sample is selected from one institution only, then it can be argued that the population studied is in fact the population of the college, rather than the wider national population, particularly if there are differences between the college population and the wider population. This is discussed below in section 3.2.3.4 and Chapter 4 (Descriptive Statistics). The research questions asked by this study should be applicable to any sample from this national population. In an application of this method by an education practitioner, the selection of a sample from this population is determined by their circumstances. In this study, however, a selection process from the wider national population needed to take place.

3.2.3.2 Sampling method

There are a variety of sampling methods available. Burroughs (1975) listed three main sampling methods: random sampling, where a purely random cross-section of the population is selected; regional selection, where a regional sample is then taken to be representative of the population; and a matched sample, where groups are matched to eliminate biases. Cohen *et al.* (2000), summarising sampling strategies, divide them into probability (equating to random sampling) and non-probability sampling methods. In a probability sample, formulae are used to determine the selection of the sample from the population; in a non-probability sample, selection criteria are used.

Of these methods, a random sample would be desirable as a non-random selection would risk bringing bias into the study. Non-random methods include regional sampling which introduces one bias – region - but limits the scope of the study by that bias, leaving all other factors free from bias. A matched sample also helps to eliminate bias, but because of differences in location, history and management of colleges, it may be difficult to find matching groups.

The best strategy in a study like this is to aim for a random or probability sample within the chosen population. Practical consideration may mean that selection criteria will be used in determining the sample, for example where it is necessary to study students in a particular class. Where that selection is not random then it is important to acknowledge the sampling bias that has been involved and to be aware of it when carrying out the analysis and in drawing conclusions.

3.2.3.3 Sample size

In acting as a model for practitioner use, the sample size is not a critical issue for this study, as the practitioner will have to make their own decisions about sample size. Discussion of the sample used in this study follows below in section 3.2.2.4 and 3.2.3.5. Standard reference to the literature suggests that a basic minimum sample size should be 30 cases (Cohen *et al.*, 2000). Borg and Gall (1989) suggests that the minimum sample sizes for different types of research are:

Correlational research...... 30

Causal-comparative........ 15

Experimental................... 15

Survey research................ 100 [Citing Seymour (1976)]

These basic rules of thumb will need to be adapted because of the impact of other factors. The more variables are considered in a survey, the greater the sample needs to be (Borg & Gall ,1989) It is also suggested that these samples sizes are a minimum requirement of the subgroups from which the sample is made up, for example in a mixed group of males and females, there should be in experimental research 15 males and 15 females. For probability research, tables of sample size are available to assist in decisions about sample size. Borg and Gall (1989) also suggested coupling guidance on sample size with a review of sample sizes in similar studies. Where a large difference is expected within the sample, a smaller sample size can be used than when the study aims to observe a smaller effect (Borg and Gall, 1989).

Referring back to the studies I used as examples above, studies which compare "interventions" in education, such as Segers *et al.* (2004), tend to have smaller sample sizes. In that study, seventy-one students across two schools were included. The sample sizes in school-effectiveness studies are often larger, for instance Van Houte (2004), took a large data sample of 3760 students in 34 schools across the Dutch school system. In Harker and Tymms (2004), the sample was 5393 students across 37 schools. Smaller scale studies such as Spector (2005) which looked at student use of IT resources on an individual student level had a sample size of 69 across four universities.

In this study practical constraints meant that a non-probability sampling approach was adopted. Criteria aimed at typicality were used in selecting a sample of students from the national population. Such an approach means that generalisation of the results of this study to the whole populations are more difficult. The parameters of this purposive sampling are discussed below.

3.2.3.4 Selection of colleges

All colleges will have their own unique circumstances, but in this study, as long as these are noted, they should not stop a valid comparison of the selected college with other colleges across the FE sector. The selected college should, for instance, offer a general curriculum rather than the specialised curriculum of, for example, an agricultural college.

The following sections outline criteria that were considered.

3.2.3.4.1 Region

There are advantages in limiting the study to one region, such as lower costs and practicability in terms of access. The selection of colleges was therefore limited to those in the West Midlands, within the range of the University of Birmingham. The issue which then arose was whether this would limit the generalisbility of the study just to the West Midlands. The generalisability would only be affected if it could be shown that there were material differences between the West Midlands region and other regions. The differences between colleges are much greater than the differences between the aggregation of colleges in a region. Chapter 4 discusses the differences between the college studied and the general population.

3.2.3.4.2 Number of colleges

As the method intends to be applicable on different scales, the number of colleges is not very important, provided it is possible to find a sufficient study sample. If more than one college is chosen then there is no temptation to adapt the study too closely to one college's organisational structure. On the other hand using a single college provides for simplicity. Many of the situations in which this method might be applied by practitioners will be within a single college.

3.2.3.4.3 Selection of colleges

Initially it was decided to approach two or three colleges for the time data survey. Although colleges might be sympathetic to the need for research, in practice, there was a feeling that such research may be disruptive and involve extra work on the part of already busy college staff. As a result of this some of the colleges approached did not offer to cooperate. Preliminary visits were made to four colleges to investigate their resources and their willingness to host a survey. At the end of this process of preliminary investigation, access to students and data proved sufficient at only one college - changes in staffing and prioritisation of workload by the staff in the other colleges meant that contact faded after the initial contacts.

Two consequences followed on from the practicality of using a single college in the research. Firstly, the sample size within that college had to be increased and, secondly a consideration of those factors which might distinguish the college population from the general population needs to be given more prominence, in order to isolate those factors which were specific to the college. These factors are considered in Chapter 4.

The initial selection of colleges was made in the following way. The investigation focused on IT usage and so a shortlist of colleges was produced based on the description of IT use in each college's official inspection report. The initial search for appropriate colleges focused on those which had instances of good practice. This approach was taken on the grounds that an evaluation into the use of IT resources would be more appropriate where those resources had already been identified as effective. Ineffective deployment of

IT resources by the college had the potential to obscure the effectiveness of IT use on student performance. At the time that this selection was being made in 1998, college inspections were carried out by the FEFC using the criteria set out in Table 3-4.

Table 3-4: Grading headings from FEFC (1993)

Inspection grading heading	Relevance to my study
Responsiveness and range of provision	This may indicate response to industry and community needs but may not directly reflect effective learning or resource use.
Governance and provision	This may have an impact on general policies towards resourcing and IT, but is not in general of relevance to the use of IT.
Students recruitment guidance and support	Does not really reflect effectiveness of the teaching methods, although it may affect institutional effectiveness or resource use.
Quality	Identified by Grey and Warrender (1995) as being related to effectiveness. However as this refers to the whole institution then this may lead to pockets of good practice being ignored.
Resources	Subdivided into: staffing equipment accommodation each with its own grade Equipment may well be relevant to the use if IT resources.
Curriculum area grades	Each organisational unit (department, faculty etc.) is given a grade. The quality is determined by the number of organisational units in the institution. This may be a guide to good practice in general, but it does not specify whether the good practice involves IT use.
College size	This is not really grading criteria, but a piece of information reported by the inspectors which may help in deciding on a college. The larger the college the easier it may be to get a sufficient sample.

The grades ranged from 1 (high) to 5 (low), and provide some guidance to how the colleges perform as institutions, with some guidance as to individual areas of good practice.

Following a review of the inspection reports for 18 West Midlands colleges, a shortlist of colleges was identified. This shortlist was based on factors such as being an improving college and being beacons of good IT use. From this shortlist contacts were made with four colleges. The information gleaned from the inspection reports regarding these four colleges is contained in Table 3-5

Table 3-5: FEFC inspection grades

College	LEA Area	Resource grade (equipment)	Quality grade	Mean curriculum grade	Total mean grade	Mean league table score (%)	*Comments from inspection reports*
Range for all 18 colleges		1 - 5	1 - 5	1.5 - 2.8	1.1 - 2.75	68 - 127	
1	Birmingham	2	2	2	1.9	103	"Extensive facilities reflect a strong commitment to the use of information technology to support students' learning" N.B. Also the subject of a case study (BECTA (1998)
2	Birmingham	4	2	N/a	N/a	68	"There is evidence of IT activity ... extending ... to substantially more than word-processing"
3	Birmingham	2	3	2.3	2.4	94	"The college has made substantial investment in the development of independent learning " but: "The college should ... establish a policy for the replacement of equipment ..."
4	Coventry	2	2	2.3	2	79	"Learning is supported by a good range of equipment and resources"
NOTES: Mean league table score is taken from the 1996 league tables (Times Educational Supplement, 22/11/96) - these being the most recent at the time when the sample was selected. They are based on: % of national mean A-level points (5.2) % of national mean GNVQ advanced completion (74.5%) % of national mean GNVQ intermediate completion (61.8%)							

The table above lists the four colleges approached together with their inspection grades for resources (equipment), quality, curriculum and the mean grade overall. I have also extracted quotes from the report concerning examples of good IT practice. Of the grades listed in this table, the resource grade is important for this study. The other grades indicate whether the use of resources was graded similarly to other aspects of the college. Colleges 1, 3 and 4 all achieved a better than average resource grade (2) and college 2 achieved a lower than average grade (4). It should be borne in mind that the resource grade applies to all types of resource and not just to IT resources. In all four colleges examples of good practice in IT were identified. The mean league table scoring predates the use of value added results and, as such, does not take account of differences in their intake profile.

All four colleges were approached and agreed to my making an initial visit. I conducted a review of their IT resources and then sought permission to obtain data from the colleges. The initial review (see Appendix 1) showed similar IT resources being used in each of the four colleges. Changes in staffing between my initial enquiries and the development of my time-data questionnaire meant that I had difficulty obtaining access to the students in colleges 1 and 3. I did manage to obtain some data from a pilot study in college 4, but contact was lost with the college before a full survey could be carried out. I then approached college 2, who were willing to give me access to both the students and their records, so that I could obtain sufficient data to analyse. College 2, although it had the lowest mean league table score, is a college in a deprived area which was identified in the late 1990s as an improving college. It had a poor resource grade (4 on a scale of 1 – 5), but areas of good practice were identified in the use of IT resources.

3.2.3.5 Sampling unit

The sampling unit focused both on the student and the course studied. Some of the factors which influence the relationship between resource use and performance may be attributable to the student; others may be attributable to the course. Two data sets are therefore needed, one which takes as its sampling unit the student and deals with factors which relate to the student such as age and gender, and another which relates to the subjects studied by the student. Each student may be studying a number of courses, for instance, a course of three A-level subjects, and the data on how they perform in each subject may relate only to that subject. A student-subject sampling unit was therefore needed as well. Each student-subject sampling unit was different even where it related to the same student, for instance, a student may spend more time in a particular activity associated with one subject than with another. Thus this sampling unit is distinct, even though the student-related data associated with it will be the same. This approach had the additional advantage of multiplying the number in the sample, helping the statistical validity of the investigation.

As a researcher, the ideal of a random or probability sample was complicated by the difficulty of gaining access to students in the selected college to carry out the survey. Access to students is dependent on the goodwill of the college, and as such there is a need to avoid too much disruption of the students' study time. A purposive, non-probability sampling approach was therefore used. As is discussed later in this chapter, two data collections were made, one at the beginning of the study over the period 1998 – 2000 (referred to as the 1998 data set), and another at the end of the study in the academic year 2006 – 2007 (referred to as the 2006 data set). In the first data collection, data were gathered by myself, having been given access to various teaching groups. The selection of these groups aimed at typicality within the selection parameters and are discussed later in sections 3.2.3.6 and 3.2.3.7. For instance, I was given access to an A-level English class, who all completed the survey on how they spent their time. All of those students were studying English A-level, but they were studying various other subjects for their other A-levels. Therefore, in the student-subject record set, there was a bias towards those students who studied English literature, but other subjects were only partially represented. In the second data collection, which was carried out after having learned from the analysis of the first, it was arranged with the college that the time-data questionnaire would be administered in tutorial time, and that the sample could be randomly selected within given parameters from the college's MIS. This eliminated the subject bias. The given parameters are discussed later in sections 3.2.3.6 and 3.2.3.7.

3.2.3.6 Selection of courses

The following issues were considered when selecting those courses studied by the sample. Firstly, given the ability of IT resources at processing and communicating information quickly it was thought better to try to concentrate on the use of information technology in information-rich subjects, for instance, history that can make use of that power to process information, rather than subjects which have a greater element of practical physical skills, for instance, PE or dance. Secondly, as this is a study of the FE sector it was considered that a representative spread of those subjects studied in FE colleges should be included, in addition to the national curriculum subjects carried forward from school. There were two collections of data, as described in 3.2.3.7 below. The first, collected in the period 1998 – 2000 ("the 1998 data set"), was used to develop the approach to analysis which is the basis of individual time-data analysis. In carrying out this analysis, certain flaws in the data collected emerged which, while not preventing analysis, suggested that improvements the data collection might provide a better analysis. A second data collection was made in the academic year 2006 – 2007 ("the 2006 data set").

In the first data collection, the subjects studied by students in the survey proved to be a wide mix, including both national curriculum subjects and new subjects introduced at college. These are listed in Table 3-6:

Table 3-6: Courses surveyed at college 2 in 1998

Faculty category	Subject	Course		
		AS	A	Other
Art & design	Art	Y	Y	
	Art and crafts	Y	Y	
	Photography	Y		
Business studies	Business studies	Y	Y	GCSE, GNVQ
	Law	Y	Y	
English	English language & literature	Y	Y	
	English literature		Y	
	Media studies	Y	Y	
General studies	General studies	Y	Y	
Humanities	Critical thinking		Y	
	History	Y	Y	
	Philosophy	Y		
	Psychology	Y	Y	
	RE		Y	
	Sociology	Y	Y	
IT	Computing	Y	Y	
	IT	Y	Y	GCSE, GNVQ
Maths	Accounting	Y		
	Maths (pure and stats)	Y	Y	
Other languages	Arabic	Y	Y	GCSE
	Urdu		Y	
	Bengali	Y		
	ESOL IELTS			Y
Performing arts	Dance		Y	
	Performing arts	Y	Y	
	Theatre studies	Y	Y	
Science	Biology	Y	Y	
	Chemistry	Y	Y	
	Physics	Y		
NOTES From the data collected from the college MIS, some of the subjects appeared to be repeated. This was due, for instance, to different syllabuses being offered in different years. These have been amalgamated in this list.				

This is a wider spread of subjects than initially intended, but is a result of the sampling method – targeting students in particular classes. This was addressed in the second data collection, in which a range of students was selected by the college. This was done within the following parameters. Firstly, students were chosen who were in their second year (studying for their A2 exams) in order to allow the collection of results. Secondly, they were in full-time education in the 16 – 19 year old age bracket in order to be "typical" of students attending a sixth form college.

In the second data collection, there was a narrower mix of courses, shown in Table 3-7 overleaf.

Table 3-7: Courses surveyed at college 2 in 2006

Faculty category	Course	Course	
		AS	A2
Art & design	Art & design		Y
	Photography		Y
	Textiles		Y
Business	Accounting	Y	Y
	Business	Y	Y
	Law		Y
English	English language & Lit		Y
	English lit		Y
	Media	Y	Y
Humanities	Geography		Y
	History		Y
	Philosophy		Y
	Psychology	Y	
	RE		Y
	Sociology	Y	Y
IT	Computing		Y
	IT		Y
Maths	Maths		Y
	Statistics		Y
Other Languages	Arabic		Y
	Urdu		Y
Performing Arts	Dance		Y
	Film		Y
	Performing arts		Y
Science	Biology		Y
	Biology (human)		Y
	Chemistry		Y
	Physics		Y

3.2.3.7 The sample used

This study uses the data from two data collections. The first data collection served to provide material to work on in developing the analytical model and the second served to test the working of the model once the issues from the first data collection were addressed. The second data collection also provides a picture from a later time period with which the earlier conclusions of the first collection can be compared.

3.2.3.7.1 The first data collection: the 1998 data set

After the initial visit to the college, in which the aims and methods of the study were set and a review of the college's resources conducted, the college agreed to grant access for the study. A second visit was made to the college once the time-data questionnaire had been devised, to pilot this questionnaire. The pilot version had an evaluation section for the usability of the questionnaire itself. As a result of this pilot, minor changes were made to the wording of the questions. The final questionnaire can also be seen in Appendix 2a. Reference to sample size tables suggested that the sample size to aim for would be around 400 if the national college population was taken to be the reference population, and around 250 if the college was taken as the whole population. Subsequent to the pilot, further visits were made to the college in which time for administering the questionnaire on students' use of time was granted with the following groups:

- A first year A-level English class
- A first year GNVQ advanced tutorial group
- A random group selected from library users
- A first year A-level sociology class
- An English as a second language class

During these two visits I spent around twenty minutes with each class explaining the purpose of the questionnaire and was on hand to answer any queries the students had about how they should answer. The students filled in the questionnaire anonymously, but used their college ID number as a unique identifier. From this identifier I was able, on a subsequent visit, to obtain data from the College's MIS on those students. This last visit, to obtain data from the college's MIS was made after the students had taken their exams, and so included their results. Some students were ultimately eliminated from the survey because no student identifier was recorded on the questionnaire, so they could not be linked up with the student records obtained from the college. In the 1998 survey 139 students and 444 student subjects were surveyed; however this problem led to the final data set used consisting of 229 student-subjects representing 88 students. This smaller sample size than the ideal needs to be acknowledged in the analysis and conclusions of the survey.

3.2.3.7.2 The second data collection: the 2006 data set

In order to improve the data collection techniques and to re-visit the research questions at a later period of time, a second data collection was organised in academic year 2006-2007. This provided a longitudinal aspect to the study which helped to build a stronger answer to the research questions by accounting for changes in the uses of IT resources over the period of the study.

The issues raised by the first data collection were discussed in a meeting with the assistant principal with responsibility for college data and an improved method was devised. The parameters for the selection of a sample were given to the college. These were that the sample should consist of students who were:

- Aged 16 – 19
- In their second year of an A-level course (i.e. they would have a final result in August 2007)
- Full-time day students

Within these selection parameters a random sample of students was made by the college from their MIS. The questionnaire from the first data collection was re-produced, along with a detailed instruction sheet for use by the students' tutors (Appendix 2c). The questionnaire was printed by the college by a direct mail merge from their MIS, which meant that the students' enrolment numbers and courses studied could be pre-printed onto the questionnaires. A cover-sheet with the student's name was attached to the questionnaire but was removed prior to being returned to me. The questionnaire was given to students during their weekly tutorial time and the instructions read out by their tutor. The tutor then collected in the questionnaires which were returned to me. Although there were some questionnaires which had to be rejected because they contained no data, as with the earlier collection, the method ensured a better return rate.

Having the sample generated directly from the college's MIS largely eliminated some of the errors encountered in the first data collection, such as students and courses not being correctly matched up. The first data set started with 139 students who provided 444 student-subjects, but once the records with unusable data were rejected, this left 88 students providing 229 student subjects, wastage rates of 37% and 48% respectively. By contrast, the second data set started with 127 students who provided 347 student-subjects. After rejecting unusable records, this left 111 students providing 319 student subjects, a much lower wastage rate of 14% and 8% respectively. The differences in the wastage rate between the student data set and the student-subject data set can be attributed to differences in the number of subjects studied by those students whose questionnaires were rejected because, for instance, they could not be matched up with a record from the college's MIS. In the first data collection, those rejected records tended to cover more subjects hence the greater percentage wastage. This perhaps suggests that those students who it was difficult to match up with their records, were not sure what courses they were studying and tended to record more subjects. This situation was reversed in the second data collection, where the rejected student questionnaires tended to cover fewer courses. Notwithstanding this, the sample in the second data collection was still smaller than the ideal.

3.3 Summary of the methodology

The intention of this study was to explore a method of studying effectiveness, based on the time spent by individual students in using resources accessible by those working in the field in education. This chapter considered firstly the methodological background of the study and then the methods used.

The study is designed from a positivist methodological standpoint, using quantitative methods to make effectiveness evaluations based on the kinds of performance measures commonly used by education managers and government departments. It was felt that this was the paradigm within which most education practitioners are required to justify their resourcing decisions.

A review of methods used in the literature suggested that there were two intersecting spectra into which studies could be placed. One dimension was that of scale, the other being that of the degree of intervention made by the investigator. This study is placed in the quadrant representing small scale studies with no intervention by the observer. The review of the literature also revealed pointers to the parameters for a study of the effectiveness of the use of IT where the technology is used to differing degrees and in differing ways by students.

The chapter then considered sampling issues and the selection of a college for the study before going on to consider issues surrounding how the effectiveness of resource use can be measured.

The study gathered data on students' performance and the time they spent using different resources. The descriptive picture of the college which is built up from this data is set out in the next chapter, before Chapter 5 attempts to address the study's research questions through a statistical analysis.

4 DESCRIPTIVE STATISTICS

This chapter uses descriptive statistics to show the make up of the student body both across the whole of the college studied and in the sample and then looks at the student-subject data, for both the 1998 and the 2006 data sets.

4.1 Student data

In investigating the factors related to the effectiveness of the use of IT resources in the college, the first stage was to build a picture of the make-up of the student body. The relationship between such factors as gender and ethnicity and the performance of students is investigated in the statistical analysis chapter, however, it is first important to develop a picture of the spread of these factors in the college and in the sample, so that the individuals can be related to the group.

The student data are reported here in terms of:

- gender
- ethnicity
- age
- access to a computer outside college
- performance data
- time data

4.1.1 Sources

The information reported below is taken from the 1999 Inspection Report (FEFC, 1999). This report was the most contemporary with the gathering of the first set data for this study. Further information on the college is derived from the 2006 Inspection Report (OFSTED, 2006). The gender and ethnicity information for the samples were derived from data provided directly by the college from their Management Information System (MIS). Age information was calculated from dates of birth provided by the college from their MIS on 1st September in the year the time data was gathered i.e. at the start of the academic year. The data on students' computer access outside college was taken from the time data questionnaire (see Appendix 2).

4.1.2 College background

The college is a Sixth Form College situated close to the centre of Birmingham. Many of the students come from ethnic minorities. The 1998 inspection report identified approximately 60% speaking English as a second language, a figure repeated in the 2001 inspection report. The 2006 inspection report noted that the "majority" of learners in the community spoke English as a second language. In 2004, 97% of learners identified themselves as belonging to an ethnic minority. Many students are from "areas of substantial economic and social deprivation" – the 1998 inspection report notes that "Unemployment in the city was 9.8% in January 1998 and 25.1% in the [local] ward" (FEFC, 1999 p. 2). This situation continues with the 2006 inspection report noting that "Approximately 90% of learners come from postcodes with a very high deprivation index and 65% of learners are in receipt of Educational Maintenance Allowances" (OFSTED, 2006, p. 4). The roll in 1997-1998 was 771 full-time students. 47% were taking advanced (level 3) courses, 24% intermediate and 29% foundation. By 2006 the student body had expanded to 1163 full-time students of whom 73% were taking advanced (level 3) courses 21% intermediate and 6% foundation. In 2004 the college was awarded beacon status and the 2006 inspection report awarded the college the top grade ("Outstanding") in four out of the five grading headings (effectiveness of provision, capacity to improve, quality of provision, leadership and management), with a grade 2 ("good") in the remaining heading (achievements and standards). The college is highly praised in the most recent inspection report for its continuing improvement.

4.1.3 Gender

The inspection report of 1999 does not have data on the gender breakdown of the student body. However, in the process of gathering background data for the sample from the college's MIS, gender data on all students enrolled at that time became available for analysis. The number enrolled is fluid, and the figures shown are for those who first enrolled in 1998 and 1999. These figures are shown table 4-1 below:

Table 4-1: Gender breakdown of the sample

		Surveyed Sample				College and national percentages for comparison			
						College		National	
		1998-99		2006-2007		1998-99	2006-2007	1998-99*	2004-2005†
		n	%	n	%	%	%	%	%
All		**88**	---	**111**	---	---	---	---	---
Gender	**M**	33	38	47	42	42	40	43*	49†
	F	44	50	64	58	58	60	56*	51†
	No Information	11	13	0	0	---	---	---	---

NOTES
* 1999 – 2000 Figure used (nearest available figure) Source: www.dfes.gov.uk, (2004)
† 2004 – 2005 Figure used (nearest available figure) N.B. the figures quoted are for student in the 16 – 19 age bracket, for all students the figures are 49.1% male, 50.9% female. Source: www.dfes.gov.uk, (2007)

The gender breakdown of the college population in 1998 shows that 58% of the students were female and 42% were male. The 2006 inspection report reports this figure as largely unchanged at 60% female and 40% male (full time students). A higher proportion of females were enrolled, the 2006 inspection report noting that 70% of learners in the community were female – i.e. those on part time courses of interest to the community run mainly "at the college, primary and secondary schools, mosques, temples, churches and community settings" (OFSTED, 1996 p. 4). This is in line with the national figures, where there is a slightly higher level of female enrolment in the FE sector, although there has been an evening out between genders nationally, over the years between the two data samples -males were up from 43% to 49% between 1998-99 and 2004-2005 with a corresponding reduction in the number of females.

The proportions of male and female students are largely unchanged between the two data collections. The apparent difference between the two collections (male 38% in 1998 and 42% in 2006; female 50% in 1998, 58% in 2006) can possibly be accounted for by the fact that in the first collection there were 13% of the students included in the study for whom there was no gender data available. If these students are ignored, then the figures are male 43% in 1998 and 42% in 2006; female 57% in 1998 and 58% in 2006. A comparison between the 1998 and 2006 data collections is therefore possible because the populations are sufficiently similar on these variables.

4.1.4 Ethnicity

As with gender data, the 1999 inspection report gives no data on the ethnic breakdown of the student body. In Table 4-2, the college figures are derived from the same data set as for the gender information above. The 2006 inspection report notes that "97% of learners identified themselves as belonging to a minority ethnic group. The college profile broadly mirrors the local population with the largest groups being Pakistani and Bangladeshi" (OFSTED, 2006, p. 4). The actual breakdown is shown in Table 4-2 overleaf.

Table 4-2: Ethnicity breakdown of the sample

<table>
<tr><th colspan="2" rowspan="4"></th><th colspan="4">Surveyed Sample</th><th colspan="4">College and national percentages for comparison</th></tr>
<tr><th colspan="4"></th><th colspan="2">College</th><th colspan="2">National</th></tr>
<tr><th colspan="2">1998-99</th><th colspan="2">2006-2007#</th><th>1998-99</th><th>2006-2007§</th><th>1998-99*</th><th>2005-2006†</th></tr>
<tr><th>n</th><th>%</th><th>n</th><th>%</th><th>%</th><th>%</th><th>%</th><th>%</th></tr>
<tr><td colspan="2">All</td><td>88</td><td>- - -</td><td>111</td><td>- - -</td><td>- - -</td><td>- - -</td><td>- - -</td><td>- - -</td></tr>
<tr><td rowspan="11">Ethnicity</td><td>Bangladeshi</td><td>15</td><td>17</td><td>19</td><td>17</td><td>14</td><td>17</td><td>1</td><td rowspan="4">7</td></tr>
<tr><td>Indian</td><td>2</td><td>2</td><td>4</td><td>4</td><td>4</td><td>2</td><td>2</td></tr>
<tr><td>Pakistani</td><td>45</td><td>51</td><td>62</td><td>56</td><td>47</td><td>48</td><td>2</td></tr>
<tr><td>Other Asian</td><td>0</td><td>0</td><td>4</td><td>4</td><td>6</td><td>5</td><td>- - -</td></tr>
<tr><td>Black African</td><td>2</td><td>2</td><td>7</td><td>6</td><td>2</td><td>12</td><td>2</td><td rowspan="3">6</td></tr>
<tr><td>Black Caribbean</td><td>7</td><td>8</td><td>4</td><td>4</td><td>5</td><td>3</td><td>2</td></tr>
<tr><td>Black other</td><td>2</td><td>2</td><td>1</td><td>10</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Chinese</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>White</td><td>4</td><td>5</td><td>4</td><td>4</td><td>7</td><td>3</td><td>89</td><td>79</td></tr>
<tr><td>Other</td><td>0</td><td>0</td><td>3</td><td>3</td><td>10</td><td>3</td><td>3</td><td>4</td></tr>
<tr><td>Not known</td><td>11</td><td>13</td><td>3</td><td>3</td><td>4</td><td>5</td><td>- - -</td><td>3</td></tr>
</table>

NOTES

* 1999 – 2000 Figure used (nearest available figure) Source: www.dfes.gov.uk, (2004)

#Although the ethnic categories available in the 2006 survey were similar to those available in 1998, there were more categories. To enable a comparison, I have aggregated some categories, for instance I have placed "mixed white and Asian" and "Mixed – Other mix" in "Other".

† 2005 -2006 Figure used (nearest available figure) Source: www.dfes.gov.uk, (2007) This breakdown was into fewer categories. I have included mixed categories here under "Other"

One of the key things to notice here is that the population of many of these ethnic groups was very small. As a result of this, in the statistical analysis chapter, the ethnic categories listed above, deriving from the classification on the college's MIS, have been aggregated as follows:

- South Asian (i.e. from the Indian subcontinent)
- Black
- White
- Other
- Not Known

The "white" ethnicity group has been retained, even though the population is very small, because it is the majority group nationally, and so needs to be included in the analysis to enable a national comparison. Notwithstanding this, conclusions derived from the statistical analysis involving this grouping must be taken with a caveat as to their importance.

The college figure in 1998 was considerably different from the national picture, with a greater proportion of students from South Asian Backgrounds – 70% of the total (Bangladeshi 13%, Indian 4% Pakistani 47% and Other Asian 6%) compared with the national breakdown of 4%. As a result of this the college had a greatly reduced proportion of white students – 8% as opposed to a national figure of 89%. The college had more black students (8% compared with a national figure of 4%). The proportion of Chinese students is similar (both round to 1%). The national figure had changed by 2006 to the extent that those categorised as white were 10% fewer than in 1998. The college figures for 2006 have not changed greatly, in proportion. There was an increase from 2% to 12% in the black African population, with a corresponding decrease in the category “other”. The 2006 data sample showed an increase in students from a South Asian background with a corresponding reduction in other categories - all Asian students aggregated to 70% in 1998 and 80% in 2006 - whereas the figure has remained largely unchanged across the college as a whole.

These substantial differences mean that although we may be able to draw conclusions about the relationship between ethnicity and the effectiveness of the use of IT resources, the distinctive ethnic profile of the college may make those conclusions less applicable to the UK college population in general.

4.1.5 Age

Information on students' ages was obtained from the two data collections, the 1999 and 2006 inspection reports along with national data obtained from the DfES website. These are compared in Table 4-3.

Table 4-3: Age breakdown of the sample

		Surveyed Sample				College and national percentages for comparison		
						College*		National
		1998-99		2006-2007		1998-99	2006-2007	2004-2005†
		n	%	n	%	%		%
All		**88**	- - -	**111**	- - -	- - -	**1163**	- - -
Age	**Under 16**	0	0.0	0	0.0	0	0	1
	16-18 years	83	94	101	91	89	89	61
	19-24 years	3	3	10	9	5	7	14
	25+ years	0	0.0	0	0	5	4	25
	Not known	4	4.5	0	0	1	0	0

NOTES
* This data set excludes those students on community courses
† 2004 – 2005 Figure used (nearest available figure) N.B. the figures quoted are for full time students only source: www.dfes.gov.uk, (2007)

The students used in the sample data collections were predominantly in the 16 – 19 year old age group (94% in 1998 and 91% in 2006). As the students in the sample are nearly all in the same age bracket, it is unlikely that age will be a variable of interest in this study. However it is included in this preliminary discussion because subsequent studies following similar methodologies may need to consider age as a variable. The data for both samples show similar proportions of students in the 16-19 age group (94% and 91%). This is a slightly smaller percentage than for the college as a whole, when community courses are excluded – 89% in both instances. However both the sample and the college data show more students in the 16-19 age group when compared to the national figures, which do not distinguish between community and general courses. (61% in 2006 in the 16 – 19 age group).

4.1.6 Computer access

The figures for computer access in the sample were taken from the following question in the questionnaire.

> Do you have access to a computer outside college?
> Please tick from of the following:
>
> - no access
> - at home - shared
> - at home - sole use
> - computers in a public library
> - computers in an "Internet Café"
> - other (please specify):

An affirmative answer in some of these categories did not preclude an affirmative answer in the other categories, which means that the total number of students who reported use outside college other than at home is not the aggregation of those who report use in a public library, an internet café or other location. However, the categories for use at home (sole use and shared use) are mutually exclusive, and so the total number who report use at home is an aggregation of those who report shared and sole use.

There are no figures available on access to computers for the college population, but there are national statistics available, and these are included in Table 4-4

Table 4-4: Students' computer access outside college

			Surveyed Sample				National percentages for comparison
			1998-99		2006-2007#		2003†
			n	%	n	%	%
Sample Size			**88**	- - -	**111**	- - -	- - -
Some use reported outside college	**At Home**	**Sole or Shared use**	64	73	97	87	58
		Sole Use	19	22	20	18	- - -
		Shared use	45	51	80	72	- - -
	Elsewhere	**Public Library**	22	25	19	17	- - -
		Internet Café	3	3	10	9	- - -
No use reported outside college			6	7	2	2	- - -
No Data			15	17	0	0	- - -

NOTES

† 2003 Figure used (nearest available figure) N.B. the figures quoted are for full time students only source: www.dfes.gov.uk, (2007)

In both data collections, 1998 and 2006, the sample reported substantially greater access to a computer at home than the general population for either of the two years covered by the survey. The national figures for access to a computer at home have been rising dramatically since national statistics were first gathered in 1985 (13%). The most recent national figure available (2003: 58%) still does not match the students reported total of 73% with either sole or shared access at home in 1998 and 87% in 2006. The national figures do not provide an age breakdown of computer use, and so those in the 16 – 19 age groups cannot be distinguished. This level of access suggests that discussions about the relationship between resource provision by the college and performance need to take account of the IT resources not provided by college. This will be addressed in more detail in the statistical analysis (chapter 6).

Table 4-4, shows that in 1998, although the majority stated that they had access to a computer at home (73%), only 22% of students reported sole use and 50% percent reported shared use. In 2006 this discrepancy had grown even greater, with 87% reporting access at home, but only 18% reported sole use – 72% reported shared use. Of the locations outside college, apart from the home where access to a computer is reported, 25% reported use in public libraries in 1998, down to 17% in 2006, possibly because there was less need with the greater access at home. The 2006 figures did, however show an increase in the use of internet cafés (9% in 2006, compared with 3% in 1998). In 1998 an internet search for such facilities showed that the nearest was several miles away. Of those who listed "other" as a location, the following were listed: family use, friends, use at work or use that was not specified.

The gender of students who reported access to computers outside college was considered. The proportions reporting use in different locations is roughly the same across both genders. It is worth noting that female students reported fewer instances of no access to a computer outside college than male students in 1998 (18% male; 11% female), however, as in 2006, this category was too small to draw conclusions from.

The ethnicity of students who reported access to computers was also considered. Most of these ethnicity groupings are too small to show anything of any significance. Students of South Asian backgrounds differed slightly from the whole sample. In 1998 there was a slightly higher sole use (27% compared with 22% for all students), whereas in 2006 there was slightly lower use (12% compared with 20% for all students). For this group in 1998 there was slightly lower shared use (47% compared with 51% for all students), but in 2006 it was similar to the figure for all students (74% compared with 73% for all students). There was roughly the same use for access in a public library (24% compared with 25% for all students in 1998, 17% and 18% in 2006). In 1998 this group reported lower internet café use (2% compared with 3% for all students), but in 2006 the figures were roughly the same. In 1998 there was a slightly lower figure for other access (3% compared with 7% for all students); in 2006, too few students reported any other access to draw any conclusions. In 1998, students whose ethnicity was unknown, showed much higher shared use (64%) and much lower sole use (0%); but there were too few students whose ethnicity was unknown in 2006 to draw meaningful conclusions.

In both 1998 and 2006, almost all the students were within the 16 – 19 age bracket, and it is suggested that no useful conclusions can be drawn from variations within this age bracket.

4.2 Student-subject data

In the previous section I described the makeup of the student body at the college used for this study. This section is focused on the students' use of time both at college and when engaged in their studies outside college.

Data in this study were collected from the time data questionnaire (see Appendix 2), which asked students how they spent their time in different activities. In that questionnaire, the students gave information on each subject that they studied. A student who was, for instance, studying three A-levels had three records in the data set. Whereas the first part of the descriptive statistics was concerned with information about the students in the sample, this section reports on student-subjects, i.e. a record of a student studying a particular subject. The performance data and time data for each student-subject may well be different, because a student who is studying three A-levels may perform differently in the three subjects, and may spend their time differently across these activities.

The time data consists of the amount of time the students said they spent in different activities (IT and non-IT related). This variable is used as an indicator of the effectiveness of the provision of resources. If time spent in a particular activity can be shown to have a stronger interrelationship with the value added score (as is investigated in the statistical analysis), then that activity, and the resources provided by the college to enable that activity to take place, may be more effective.

4.2.1 Student-subjects compared with the student body

The statistical analysis takes as its unit each record i.e. a student studying a subject. Therefore a student studying more subjects will have a greater influence on, for example, the ethnic and gender spread of the sample.

Table 4-5: The student-subjects data set compared with the student body data set

A	B	C	D	E	F	G	H	I	J
Variable		**Student-Subject data set (Numbers)**		***Mean courses per student in each category***		**Comparison between the student data set a(left hand column) and the student-subject data set (Right hand column)**			
		1998	***2006***	***1998***	***2006***	***1998***		***2006***	
All		**229**	**319**	**2.7**	**2.9**				
Gender	**M**	80	132	2.4	2.8	34.9	37.5	42.3	41.4
	F	121	187	2.9	3.0	52.8	50.0	57.7	58.6
Ethnicity	**Bangladeshi**	30	53	2.1	2.8	13.1	17.0	18.9	16.6
	Black African	7	12	3.5	2.9	3.1	2.3	7.2	6.3
	Black Caribbean	23	11	3.8	2.8	10.0	8.0	3.6	3.4
	Black Other	3	3	1.5	3.0	1.3	2.3	0.9	3.4
	Chinese	0	0	- - -	- - -	0.0	0.0	0.0	0.0
	Indian	5	12	2.5	3.0	2.2	2.3	3.6	3.8
	Pakistani	119	178	2.6	2.9	52.0	51.1	59.5	55.8
	White	14	12	3.5	3.0	6.1	4.5	3.6	3.8
	Other Asian	0	11	- - -	2.8	0.0	0.0	3.6	3.4
	Other	0	7	2.8	3.0	0.0	0.0	0.9	1.3
Age	**16 - 18**	197	290	2.7	2.9	97.4	97.7	91.0	90.9
	19 +	6	29	3.0	2.9	2.6	2.3	9.0	9.1
NOTES: Of the 229 student subjects in the 1998 student-subject data set, 28 had no student data									

Table 4-5, shows that there is very little variation between the percentages of the two data sets (student body and student subjects) represented by the different categories listed in column B for both the 1998 data collection (compare columns G and H) and the 2006 data collection (compare columns I and J. Where there is a difference between the student and the student-subject data set, such as among some of the ethnic groups, the group size is small and minor differences are exaggerated. An example of this is as follows. There were only 15 Bangladeshi students (consisting of 30 student-subjects) in the 1998 data collection. There were more Bangladeshi students in the student body data set (17%) than in the student –subject data set (13%) – difference of 4% whereas for a larger category (e.g. Pakistani students), this difference is only 1%.

Where there is an increase in the proportions for a category it indicates that those in that group are reporting more subjects studied. Where the population is large enough to show a meaningful trend and shows a greater number of courses, it will be more represented in the student-subject data set than in the student data set. For instance, in 1998 female students studied more courses (2.9 in 1998 and 3.0 in 2006) on average than males (2.4 in 1998 and 2.8 in 2006), and so any interrelationship between performance and female gender should be more pronounced in the student-subject data set than in the student data set.

It is noticeable that there is a smaller variation in the number of courses reported by students in the 2006 data collection which is largely due to the improvements in the data collection techniques. In 1998, the data collection questionnaire relied entirely on the students to report which courses they were studying. In 2006 this information was pre-printed on the questionnaire by the college with course information from their MIS.

4.2.2 Courses studied by the students in the sample

4.2.2.1 Course categorisation

In the 1998 student-subjects data set, the students reported they were studying across a range of 59 subjects. When cross-referenced against student records obtained from the college this showed up as 72 separate subject designations (although many of these were very similar e.g. “biology A-level” and “biology A-level UCLES 9962 from 97 onwards” – both reported by the student as “biology A-level”). This issue was avoided in the 2006 data collection, by having the course information pre-printed. Despite this, however, there were still a couple of instances where students reported on courses which did not appear pre-printed on the questionnaire. This may have been because of changes to their courses between the printing of the questionnaire and the student filling it in; for 2006 there were 32 courses reported on.

In order to create manageable variables in the regression analysis, these courses were categorised by faculty within the college.

The college's faculty structure in the period in 1998 when the study took place was as follows:

Table 4-6: Faculty structure in the college studied

Faculty	Department	Courses covered included
1	Art & design	Art, photography, textiles, fashion
2	Business studies	Business, accounts, law
3	English	English
4	Humanities and social studies	History, psychology, RE, philosophy, sociology
5	IT	ICT, computing, CLAIT
6	Maths	Maths, statistics
7	Other languages	Foreign languages, ESOL
8	Performance arts	Performing arts, dance, theatre studies, drama, music
9	Science	Physics, chemistry, biology
10	Services & people	Health & social care, nursing, early years, leisure, leisure & tourism

The faculty structure was the same in 2006, which makes for an easy comparison. As none of the students in the study reported on courses from faculty 10 – services and people, I have omitted this category from the analysis. However, many students reported studying general studies, which is cross-curricular. I have therefore replaced category 10 with a separate category for general Studies.

Table 4-7 shows the spread of student-subjects in the different faculty categories.

Table 4-7: Numbers in each faculty category

Faculty		1998		2006	
		n	%	n	%
All		229	- - -	319	- - -
1	Art & design	8	3	20	6
2	Business studies	41	18	25	8
3	English	37	16	47	15
4	Humanities and social studies	45	20	86	27
5	IT	23	10	9	3
6	Maths	16	7	33	10
7	Other languages	5	2	8	3
8	Performance arts	11	5	11	3
9	Science	31	14	80	25
10	General studies	12	5	0	0

In 1998 the survey was performed with a number of different groups in which the students were all following the same subject. For a group studying e.g. GNVQ business, all the students in that group recorded time data for GNVQ business plus their other courses. This therefore means, for example, that business students are over represented (18% in the sample compared with 5% in the college as a whole), as one of the groups surveyed contained a large number of GNVQ students; however, this is not always the case, for instance there were 16% English students in the sample as opposed to 15% in the college as a whole, despite an English A-level group being surveyed. Looking at the spread of courses across the faculties no clear pattern emerges.

The 2006 sample was selected by the college from their MIS within certain requested parameters. The students were full time students, aged 16 – 19 doing level 3 qualifications. Most subjects were offered at level 3 and at level 2 (e.g. A-level and GCSE), and so this should not have had an impact on Table 4-7 above. For this grouping no clear pattern emerges, as with the 1998 survey, with regard to subject studied.

4.2.2.2 Course statistics

In this section the faculty categories are broken down by key characteristics of the students who are studying the subjects. These are analysed further as variables in the statistical analysis chapter. The characteristics are gender, ethnicity and access to a computer outside college.

4.2.2.2.1 Gender

Table 4-8: Course categories by gender

		Gender Category							
		All		Male		Female		No data	
Faculty category	Collection		%	n	%	n	%	n	%
All	1998	229		80		121		28	
	2006	319		132		187		0	
1 Art & design	1998	8	3	1	1	6	5	1	4
	2006	20	6	4	3	16	9	;0	0
2 Business studies	1998	41	18	18	23	17	14	6	21
	2006	25	8	12	9	13	7	0	0
3 English	1998	37	16	4	5	27	22	6	21
	2006	47	15	17	13	30	16	0	0
4 Humanities and social studies	1998	45	20	11	14	21	17	13	46
	2006	86	27	23	17	63	34	0	0
5 IT	1998	23	10	14	18	9	7	0	0
	2006	9	3	3	2	6	3	0	0
6 Maths	1998	16	7	13	16	3	2	0	0
	2006	33	10	21	16	12	6	0	0
7 Other languages	1998	5	2	2	3	2	2	1	4
	2006	8	3	4	3	4	2	0	0
8 Performance arts	1998	11	5	2	3	9	7	0	0
	2006	11	3	3	2	8	4	0	0
9 Science	1998	31	14	13	16	18	15	0	0
	2006	80	25	45	34	35	19	0	0
10 General studies	1998	12	5	2	3	9	7	1	4
	2006	0	0	0	0	0	0	0	0

The DfES uses a different categorisation, which is shown in Appendix 3a for comparison.

In most categories, female students appear as a greater proportion than male students.

Overall around 40% of students are male.

The following points are of note.

Faculty category	Comment
Art and design	In the national statistics (see Tables 1 and 2 in Appendix 3a) art is counted with performing arts. The national trend is that more girls than boys study arts subjects, which is also true in the two samples in this study. There was a slight increase in the proportion of arts students in the 2006 sample.
Business studies	Nationally, the greater proportion of business students is female. In the two samples more males than females studied business subjects, although the figures were more even in 2006 (the ratio was 23%:14% in 1998 compared with 8%:7% in 2006).
English	In the national sample English is counted with other languages. A comparison with national results is not very useful, as the ethnic composition of the college and the sample, already noted, mean that a greater proportion of the students in the college study other languages. In both the 1998 and the 2006 samples the proportion of female students studying English is greater; a ratio of 5:22 (male:female) in 1998 and 13:16 in 2006, and so in 2006 the proportion was more even. As a proportion of all students, there was little difference between the years.
Humanities and social studies	The greater proportion of female students studying humanities subjects in the sample reflects national trends. In 1998 The humanities

	department was larger in the sample (20%) than in the college as a whole (14%).
IT	The situation with the sample is the opposite from national trends – with fewer female students studying IT than males in the sample, it is the reverse in the national data. In the 1998 sample, the department is representative of the college as a whole (10% of students), however this is smaller than the national profile.
Maths	Although the national statistics count maths with science, a slightly greater proportion of females study science/maths. In both samples the proportion of male students studying maths greatly outweighs female students.
Other languages	Languages are linked with English in the national statistics, but show a greater proportion of female participants. In both samples the number of students reporting was small, making it difficult to draw any meaningful conclusions about gender split in this subject area.
Performance Arts	Linked with arts in the national statistics, the picture shows greater female than male participation. In the sample the same was true.
Science	Although the national statistics count maths with science, a greater

	proportion of those studying science/maths were female. In the two samples the proportion of female students studying science outweighed male students
General Studies	This subject is not referred to in the national statistics, and is only represented by a few students in the 1998 sample. In the 2006 sample, there were no students taking general studies.

In both samples there were no students in the services and people department. This makes up 20% of the college which compares to around 25% nationally. It is an aggregate of several classifications to fit in with the make up of the department in the college (e.g. health and social care, nursing, early years, and leisure and tourism courses).

When conducting statistical analyses of these results, it is important to bear in mind that there is a slight gender bias in some subjects. Any interrelationship between gender and performance needs to be distinguished from any interrelationship which may exist with the subject studied. This is achieved through the multiple regression analysis model described in the next chapter. Once gender differences have been distinguished from the subject differences, then the differences between the gender makeup of the sample and the national population do not affect the generalisability of the study's conclusions with regard to the subject studied.

4.2.2.2.2 Ethnicity

As has already been noted, some ethnicity categories are small and so are unlikely to show us much of interest. As a result the following amalgamations have been made in Table 4-9 below:

1) "Asian" includes the categories Bangladeshi, Indian, Pakistani and other Asian.

2) "Black" includes Black African, Black Caribbean & Black other.

Ethnic categories where there were no students (e.g. "Chinese", "other") have been omitted.

Table 4-9: Course categories by ethnicity

Faculty category	Ethnic Category									
	All		Asian		Black		White		Other/Not Known	
		%	n	%	n	%	n	%	n	%
All (1998)	229		154		33		14		28	
All (2006)	319		254		34		12		19	
1 Art & design (1998)	8	**3**	5	**3**	0	**0**	2	**14**	1	**4**
1 Art & design (2006)	20	**6**	11	**4**	3	**9**	6	**50**	0	**0**
2 Business studies (1998)	41	**18**	28	**18**	7	**21**	0	**0**	6	**21**
2 Business studies (2006)	25	**8**	19	**7**	2	**6**	1	**8**	3	**16**
3 English (1998)	37	**16**	19	**12**	10	**30**	2	**14**	6	**21**
3 English (2006)	47	**15**	39	**15**	5	**15**	2	**17**	1	**5**
4 Humanities and social studies (1998)	45	**20**	23	**15**	6	**18**	3	**21**	13	**46**
4 Humanities and social studies (2006)	86	**27**	74	**29**	7	**21**	2	**17**	3	**16**
5 IT (1998)	23	**10**	21	**14**	2	**6**	0	**0**	0	**0**
5 IT (2006)	9	**3**	9	**4**	0	**0**	0	**0**	0	**0**
6 Maths (1998)	16	**7**	15	**10**	1	**3**	0	**0**	0	**0**
6 Maths (2006)	33	**10**	27	**11**	3	**9**	0	**0**	3	**16**
7 Other languages (1998)	5	**2**	4	**3**	0	**0**	0	**0**	1	**4**
7 Other languages (2006)	8	**3**	6	**2**	1	**3**	0	**0**	1	**5**
8 Performance arts (1998)	11	**5**	2	**1**	4	**12**	5	**36**	0	**0**
8 Performance arts (2006)	11	**3**	4	**2**	5	**15**	1	**8**	1	**5**
9 Science (1998)	31	**14**	29	**19**	0	**0**	2	**14**	0	**0**
9 Science (2006)	80	**25**	65	**26**	8	**24**	0	**0**	7	**37**
10 General studies (1998)	12	**5**	8	**5**	3	**9**	0	**0**	1	**4**
10 General studies (2006)	0	**0**	0	**0**	0	**0**	0	**0**	0	**0**

It should be noted that the variations in the representation of ethnic groups between the course categories differ in both the 1998 and the 2006 data collections, as would be expected with the numbers which are still small. As with gender any interrelationship between ethnicity and performance needs distinguishing from the subject studied in the analysis and this is done through the multiple regression model employed in the next chapter.

4.2.2.2.3 Age

For both data collections, most of the students are within the same 16-19 age group. In the table below, the students have been broken down further by age in years. The breakdown can be seen in Table 4-10.

Table 4-10: Course categories by age

Faculty category	Age Category All		16		17		18		19+	
		%	n	%	n	%	n	%	n	%
All (1998)	229		140		65		18		6	
All (2006)	319		3		201		86		29	
1 Art & design (1998)	8	3	3	2	5	8	0	0	0	0
1 Art & design (2006)	20	6	0	0	16	8	3	3	1	3
2 Business studies (1998)	41	18	25	18	14	42	2	11	0	0
2 Business studies (2006)	25	8	0	0	17	8	7	8	1	3
3 English (1998)	37	16	19	14	13	39	4	22	1	17
3 English (2006)	47	15	2	67	32	16	12	14	2	7
4 Humanities and social studies (1998)	45	20	22	16	19	58	2	11	2	33
4 Humanities and social studies (2006)	86	27	1	33	57	28	21	24	6	21
5 IT (1998)	23	10	17	12	3	9	2	11	1	17
5 IT (2006)	9	3	0	0	5	2	4		0	0
6 Maths (1998)	16	7	16	11	0	0	0	0	0	0
6 Maths (2006)	33	10	0	0	20	10	8	9	5	17
7 Other languages (1998)	5	2	0	0	2	6	3	17	0	0
7 Other languages (2006)	8	3	0	0	3	1	4	5	1	3
8 Performance arts (1998)	11	5	4	3	5	15	2	11	0	0
8 Performance arts (2006)	11	3	0	0	6	3	2	2	3	10
9 Science (1998)	31	14	27	19	1	3	1	6	2	33
9 Science (2006)	80	25	0	0	45	22	25	29	10	34
10 General studies (1998)	12	5	7	5	3	9	2	11	0	0
10 General studies (2006)	0	0	0	0	0	0	0	0	0	0

A search for patterns in the above table results in the following observations: firstly, in 1998, the proportion of students studying English was greater in the older age categories in the sample; secondly, all students studying maths are aged 16 in the sample; thirdly the proportion of students studying science in the sample is greater in the two end categories (16 and 19+). The majority of the 2006 sample were aged 17.

4.2.2.2.4 Computer access

As with previous categorisations, a categorisation by computer access leaves small sample sizes and it is difficult to discern patterns in the data. This may be a reflection that this is a student- related factor rather than a subject related factor, and may not, therefore, be of any importance when it comes to the student-subject data set.

4.2.3 Time data

4.2.3.1 Total time spent

The time data questionnaire asked students to record their estimate for the total amount of time they spent each week on the subject.

I was available when the questionnaire was run during the 1998 data collection and able to clarify with students their questions as to what time to count or not count. For the 2006 data collection, my experience of the 1998 data collection allowed me to provide guidance for the students' tutors who gave their students the questionnaire (see Appendix 2c).

The following tables show the spread of the replies to this question.

4.2.3.1.1 Gender

Table 4-11: Student data statistics - gender

GENDER		Statistic: Total Time per subject reported on in hours per week												
		All			0-5 Hrs		5-10 Hrs		10-15 Hrs		15-20 Hrs		Over 20 Hrs	
Category		***n***	***%***	***Mean Hrs***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***
All (1998)		229		8.8	51	%	105	%	41		14		18	
All (2006)		319		11.4	38		148		93		24		16	
Gender	**M (1998)**	80	35	9.1	24	47	32	31	10	24	3	21	11	61
	M (2006)	132	41	15.7	20	53	60	41	35	38	5	21	12	75
	F (1998)	121	53	8.7	18	35	63	60	28	68	5	36	7	39
	F (2006	187	59	10.0	18	47	88	60	58	62	19	79	4	25
	No info (1998)	28	12	8.0	9	18	10	10	3	7	6	43	0	0
	No info (2006)	None												

NOTES:
1) The percentages shown here are percentages within the category, i.e. the 24 male students in 1998 who were in the 0 – 5 hours category are 47.1% of the 51 students in total in the 1998 0 – 5% category
2) The Over 20 hours category is open ended and accounts for the tail. The most reported hours by any student is 40 Hours (mean=27.9 Hours).
3) The percentages for these categories are based on the number in the category, not in the whole sample

The main point to notice from this table is that male students report a greater total time per week spent overall in both data collections - a mean of 9.1 hours compared with females at 8.7 in 1998 and a mean of 15.7 hours compared with females at 10.0 in 2006. The representation in the different categories can be seen in the following charts, which show how the percentage of each gender category varies with the amount of total time reported.

Figure 4-1: Student data statistics – gender (1998)

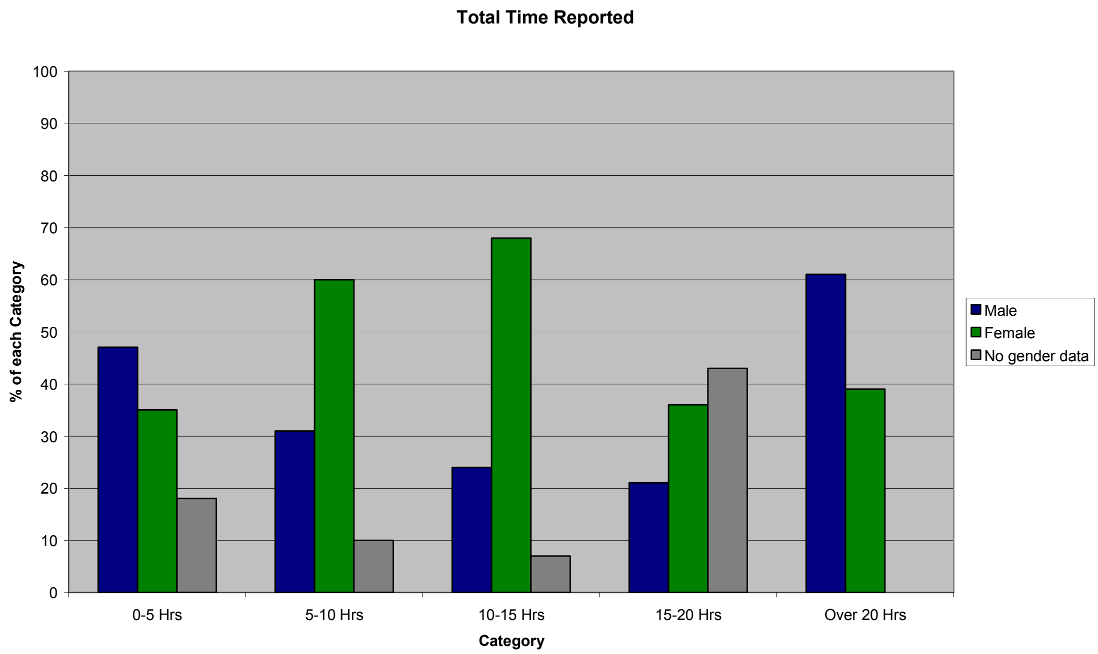
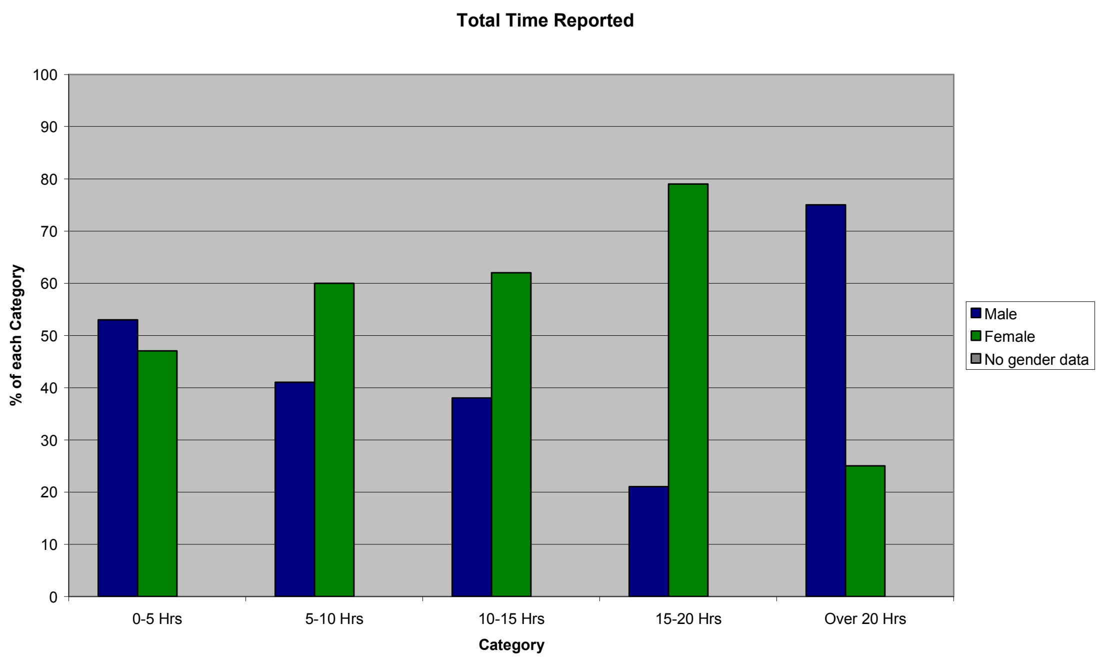


Figure 4-2: Student data statistics – gender (2006)



Although the mean total time reported by male students was greater than for female students, the trend in both data collections is for the proportion of female students to increase in each successively longer time category. It is only the small final category, over 20 hours, which distorts the figure, giving male students the greater average total time. This category is not so small as to be insignificant, but is still small. It is of interest, given the difference in the results between 1998 and 2006 discussed in the analysis in Chapter 5, that there is no noticeable difference in the picture built up from the breakdown of the total time spent by gender between 1998 and 2006.

4.2.3.1.2 Ethnicity

Table 4-12, below, sets out the students' replies as categorised by ethnicity:

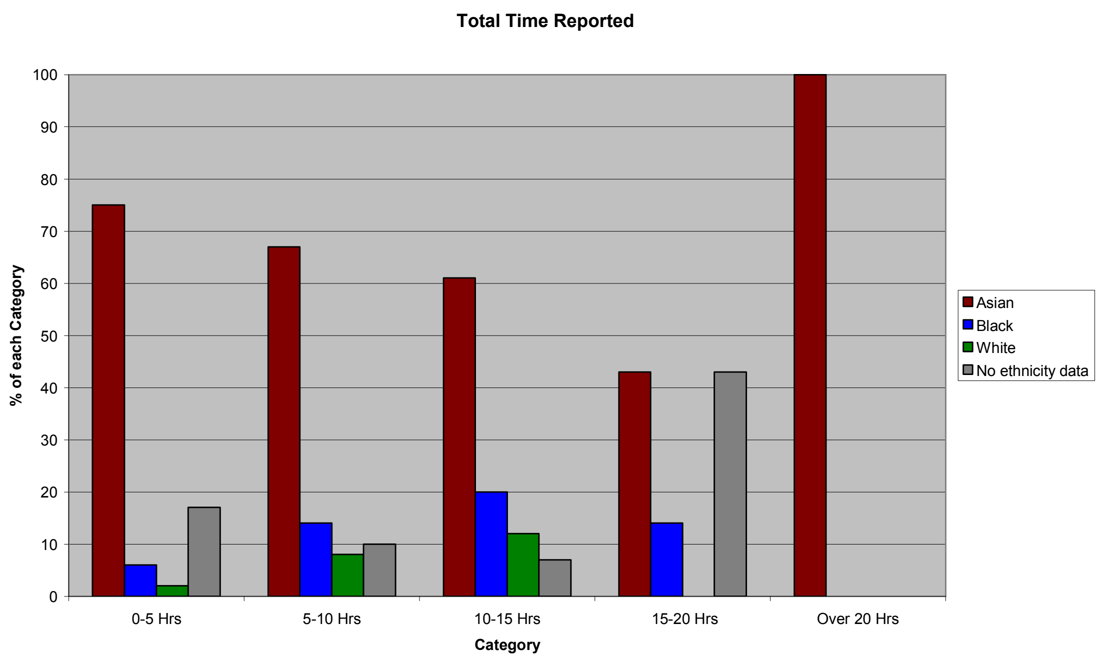
Table 4-12: Student data statistics - ethnicity

ETHNICITY		Statistic													
		All			0-5 Hrs		5-10 Hrs		10-15 Hrs		15-20 Hrs		Over 20 Hrs	
		n	*%*	*Mean Hrs*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
All (1998)		229		8.8	51		105		41		14		18	
All (2006)		319		8.9	38		148		93		24		12	
Ethnicity	Asian 1998	154	67	9.3	38	75	67	67	25	61	6	43	18	100
	Asian 2006	254	80	8.9	27	71	125	84	75	81	18	75	9	75
	Black 1998	33	14	7.6	3	6	20	14	8	20	2	14	0	0
	Black 2006	34	10	6.7	10	26	14	9	8	9	2	8	0	0
	White 1998	14	6	6.9	1	2	8	8	5	12	0	0	0	0
	White 2006	12	4	12.3	0	0	4	3	4	4	4	17	0	0
	No info (1998)	28	12	8.0	9	17	10	10	3	7	6	43	0	0
	No info (2006)	19	6	8.6	1	4	9	6	6	6	0	0	3	25

NOTE:
The following amalgamations have been made to the ethnic categories, because of the small population of certain categories:
1) "Asian" above includes the categories Bangladeshi, Indian, Pakistani and other Asian
2) "Black" includes Black African, Black Caribbean & Black other
3) Ethnic categories where there were no students (e.g. "Chinese", "other") have been omitted

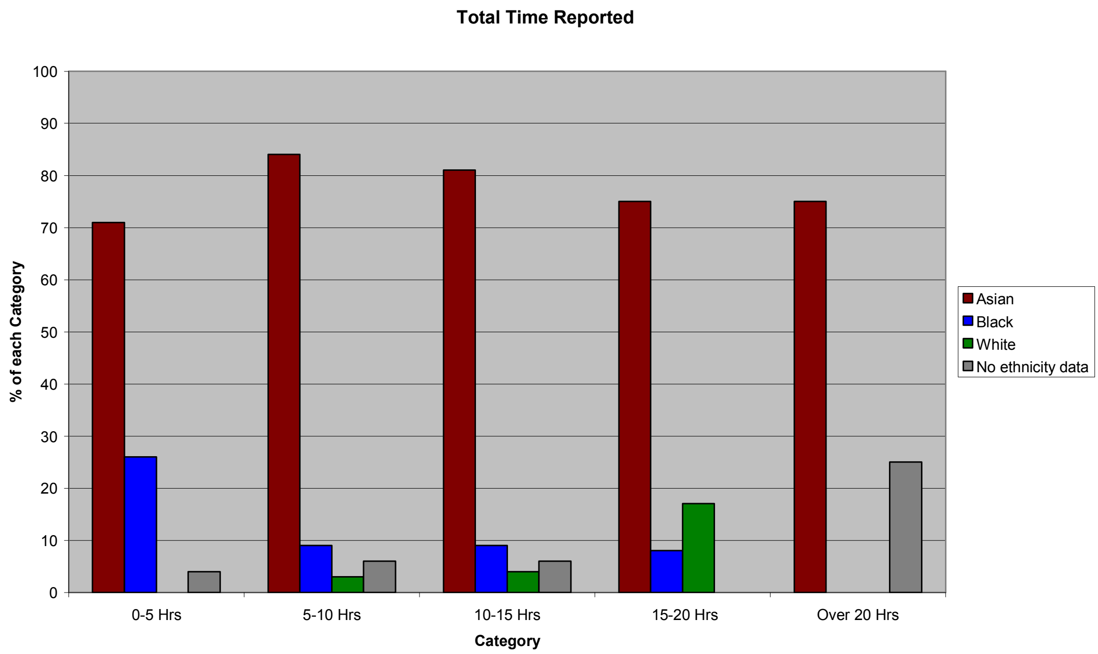
Of note in this table is that students from Asian ethnic backgrounds reported higher total times for all activities. In 1998 the mean for all students was 8.8 hours but the means for the different ethnicity categories were: Bangladeshi 10.2, Indian 7.0, Pakistani 9.1. In 2006 these figures were: all students 8.9; Bangladeshi 8.3 Indian 9.7, Pakistani 8.9. The following charts show how the percentage of each ethnicity category varies with the amount of total time reported:

Figure 4-3: Total time reported – ethnicity (1998)



The chart shows that although students from an Asian background report longer total hours, this can be accounted for by the tail (the over 20 hours category). The proportion of Asian students decreases with each longer time category. While the proportion of Black and White students increases slightly and then remains largely the same, although none are represented in the final "over 20 hours" category.

Figure 4-4: Total time reported – ethnicity (2006)



In 2006 the distribution of the ethnicity categories was fairly evenly spread across the categories for total time spent. This is in contrast to 1998 where it appeared that the proportion of Asian students decreased with each category.

4.2.3.1.3 Age

It should be noted that most students fell into the 16-19 year old age group. When the actual ages of the students are plotted no clear pattern emerges in terms of the total amount of time each student reported spending working, the distribution following a flat curve.

4.2.3.1.4 Computer access

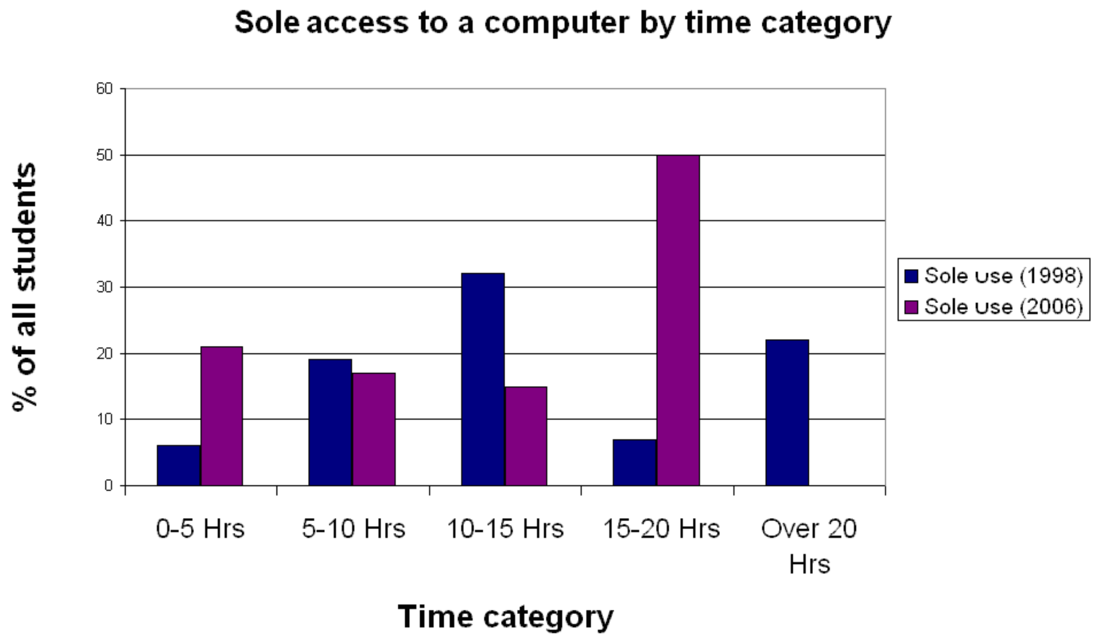
Table 4-13 sets out how students reported their access to a computer outside college. This time data from the questionnaire is categorised as above.

Table 4-13: Computer access statistics

Computer Access			Statistic												
			All			0-5 Hrs		5-10 Hrs		10-15 Hrs		15-20 Hrs		Over 20 Hrs	
Category			*n*	*%*	*m*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
All (1998)			229		8.8	51		105		41		14		18	
All (2006)			319		8.9	38		148		93		24		12	
Anywhere	At Home	Sole use (1998)	41	18	10.3	3	6	20	19	13	32	1	7	4	22
		Sole use (2006)	59	18	9.5	8	21	25	17	14	15	12	50	0	0
		Shared use (1998)	126	55	8.3	33	65	62	59	15	37	4	29	12	67
		Shared use (2006)	223	70	9.2	19	50	122	82	70	75	12	50	10	83
	Elsewhere	Public library (1998)	52	23	8.1	17	33	19	18	9	22	4	29	3	17
		Public library (2006)	53	17	9.0	7	18	24	16	19	20	2	8	1	8
		Internet café (1998)	9	4	5.0	4	8	5	5	0	0.	0	0	0	0
		Internet café (2006)	28	9	8.1	1	3	16	11	9	10	2	8	0	0
		Other (1998)	14	6	9.9	0	0.	7	7	6	15	0	0	1	6
		Other (2006)	7	2	11.6	0	0	3	2	2	2	1	4	1	8
Nowhere (1998)			43	18.8	8.7	8	16	17	16	10	24	8	57	0	0
Nowhere (2006)			5	2	4.8	3	60	2	40	0	0	0	0	0	0
No data (1998)			1	0.4	6.0	0	0	1	1	0	0	0	0	0	0
No data (2006)			0	0	0	0	0	0	0	0	0	0	0	0	0

The table above shows that in the student-subject data set, those records showing sole-use of a computer at home also reported a greater average total time for all activities, 10.3 hours compared with a mean of 8.8 hours in 1998 and 9.5 compared to a mean of 8.9 in 2006. The figure 4-5, illustrates that those who reported sole use of a computer tended to spend more time in total in 1998 but less time in 2006.

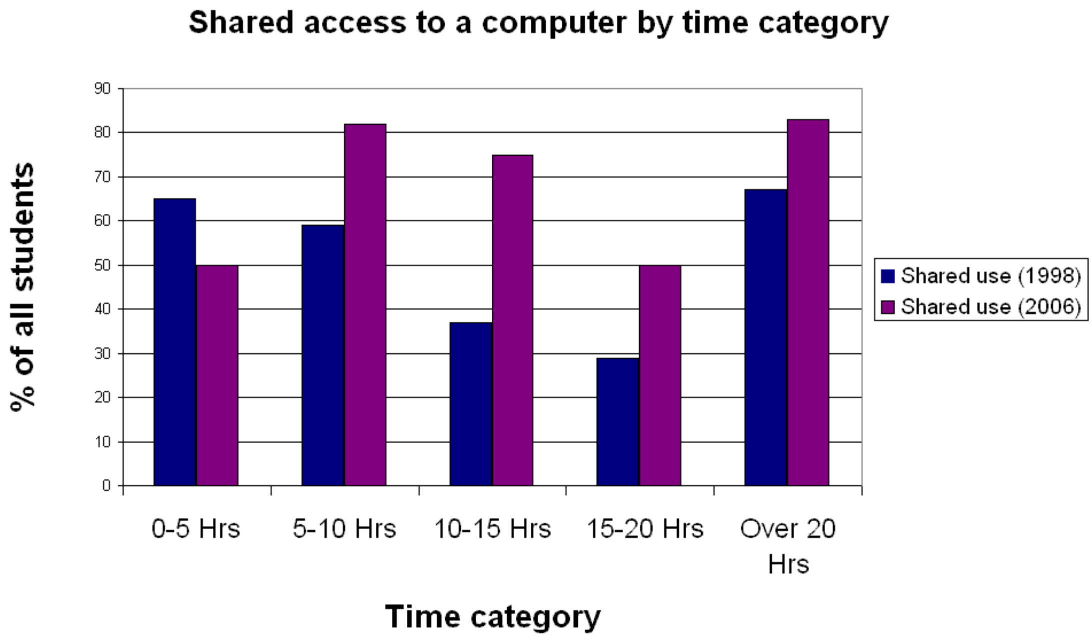
Figure 4-5: Shared access to a computer by time category (sole use)



The chart shows that in 1998 the trend in proportion of those with sole use of a computer at home increases with each increasing time category in the lower time categories, with this trend tailing off after 15 hours, and that the proportion of those with shared use diminishes. The trend in 2006 appears to be the opposite of this.

In 1998 those who reported shared access at home showed a lower mean total time than for all students (8.3 as opposed to 8.8 hours), whereas in 2006 those with shared access at home reported a greater mean number of hours than the whole group (9.2 compared with 8.9). The figure 4-6, shows how those who report shared use are better represented in the upper time categories in 2006 than in 1998.

Figure 4-6: Shared access to a computer by time category (shared use)



It is also interesting to note that although a greater percentage in total reported shared access to a computer in 2006 (70%) than in 1998 (55%), the percentage reporting sole access to a computer remained the same in the two years (18%).

There were a greater percentage of students in 2006 who reported the use of internet cafés (9% in 2006, 4% in 1998). Those who reported the use of a computer in an internet café showed a slightly lower total mean time spent (8.1 hours). However, although the sample was bigger in 2006 than the 1998 sample, it is still too small to draw firm conclusions from this.

4.2.3.2 Statistics – individual activities

Data was gathered on how students actually spent their time in the different activities listed. These activities were.

IT based activities

- Word-processing
- Spreadsheets
- Desk top publishing
- Information on a CD ROM
- Information on the Internet
- E-mail
- Other (not listed above)

Non IT based activities

- Direct input from teacher
- Doing group or individual activities
- Using books, periodicals or other paper-based learning materials
- Other (not listed above)

Students were asked how much time they spent in each of these activities in each of the following settings: in class; in college outside class (e.g. in the library); and outside college (e.g. at home).

When it came to the statistical analysis (see Chapter 5), problems with co-linearity meant that these 11 activities categories were aggregated together for the multiple regression analysis into six categories:

- IT activities in college in class
- IT activities in college outside class
- IT activities outside college
- non-IT activities in college in class
- non-IT activities in college outside class
- non-IT activities outside college

Once aggregated, Table 4-14, shows the mean time spent in each activity.

Table 4-14: Individual IT and non-IT based activities

Activity	Mean Time reported for this activity (Hours)	
	1998	2006
IT activities In college in class	0.96	0.88
IT activities In college outside class	0.8	1.33
IT activities outside college	0.88	1.54
Non-IT activities In college in class	4.32	2.88
Non-IT activities In college outside class	0.97	1.82
Non-IT activities outside college	1.38	1.95

NOTE:
Because there is a wide difference between the sum of all reported activities and the separately reported total time spent figure data, I used the following formula to come to a proportional estimate of the time taken in different activities:

$$\frac{\text{Time reported for individual activity}}{\text{Sum of the time reported for all individual activities}} \times \text{Time reported as total time spent in various learning activities (data directly obtained in a separate question)}$$

As can be seen, the greatest time is spent in class with didactic input from the teacher, and this was more pronounced in 1998 than in 2006. It is important to bear in mind that this reporting of time represents students' impression of the time spent rather than actual time. There is a suspicion here that some students, particularly in 1998 have recorded their total timetabled time in class rather than the time spent in didactic activities, although the difference was explained to the students at the time of administering the questionnaire, either by myself in 1998 or by the tutors in 2006. There is further discussion of the difficulties of working with time data as reported by students in Chapters 5 and 6 below.

A breakdown of the data on students' reported use of activities by the various categories used earlier in this chapter can be seen below. This looks at the number of student-subjects in each category who report a figure for this activity which is not zero. The purpose of the basic analysis in this section is to describe the general pattern of how IT and non-IT resources were used by the sample.

4.2.3.2.1 Gender

The activity split by gender reveals that neither gender category shows any clear difference in terms of participation in different activities. There was less difference shown in 2006 than in 1998. In 1998 35% of students were male and the percentage of males reporting activity in different categories varies from 33% (IT in college outside class) to 42% (IT in class). In 2006 41% of males reported participation across the categories ranging from 39% (each of the IT categories) to 43% (non-IT outside college). In 1998 a slightly greater proportion of female students reported use of IT in class (58%: female students make up 53% of the whole sample), but this was less noticeable in 2006. The full breakdown is included in Table 3 in Appendix 3b.

4.2.3.2.2 Ethnicity

In 1998, the proportion of those from the Asian ethnicity category participating in IT based activities was greater than the proportion of the sample in general, i.e. 86% where this category only accounts for 67% of the sampled population as a whole. In 2006, this was not the case with 80% of the students being of Asian origin, and 78% reporting IT use in class. This example is an indication of the fact that, as with gender, there was less variation in the 2006 data collection. The variations in the proportion of both Black and White students were almost the same for all activities as for the sample in general, when apparent differences with categories which had small sample sizes were disregarded. The proportion of those students whose ethnic origin was not known varied. The full breakdown is included in Table 4 in Appendix 3b.

4.2.3.2.3 Age

No clear pattern emerges from the age breakdown of participation in different activities. The full breakdown is included in Table 5 in Appendix 3b

4.2.3.2.4 Computer access statistics

Participation rates in the different activities in 1998 and 2006 vary slightly for those who use IT at home, including shared and sole use, although this was more pronounced in the 1998 sample. Those who reported access to a computer at home made greater use outside college: in 1998, 55% of students shared access at home, but 64% reported they used a computer outside college suggesting that this access encouraged use outside college. This increase was even greater for those who reported sole access with an increase of 44%. The same trend was observed for the 2006 data collection, but was less pronounced, 11% increase for those with sole access and 1% for those with shared access.

For those who have access to IT resources outside college other than at home, the small numbers must be borne in mind, but the general trend in both data sets was that a greater proportion of those who report use in a public library participate in IT activities and fewer participate in non-IT activities. For instance, in 1998 50% more of the students who used a public library reported use of IT resources in the classroom whereas 14% fewer reported participation in non-IT resources in college outside class. In 2006 the same general picture was apparent, although the sample was smaller and so it was harder to discern a meaningful pattern.

For those who report no access to IT facilities in 1998 there was a greater participation in IT activities in college outside class but less in IT activities in class and outside college. As a group, however, they report greater participation in all activities. In 2006 the sample size was too small to give a meaningful picture.

The full breakdown of these figures is included in Table 6 in Appendix 3b.

4.3 Conclusion

4.3.1 The student data set

A study of this kind seeks to gather and analyse data on a sample in order to emulate processes and patterns which are presumed to represent wider populations. In the case of this study there are known statistics for such variables as age, sex and gender for the whole population and any differences made with the sample were noted. A comparison has been made between the sample and two wider levels of population - the college as a whole and national figures. With this comparison a study of the descriptive statistics can identify the potential applicability and limitations of any conclusions. The small numbers involved in some of the subcategories described require some caution in the interpretation of the data.

This section of the conclusion is focused on data which relate only to students, such as age, ethnicity and gender. The next section focuses on data which are dependent on the different courses the students study.

The samples in both 1998 and 2006 showed a similar breakdown to both the college as a whole and to national data, except in the case of ethnicity. A further difference was that the sample was biased towards students in the 16-19 age group whereas there was a greater proportion of older students in the college as a whole. This is because the samples in 1998 and 2006 were chosen from students studying full-time daytime A-level and the equivalent vocational courses (GNVQ in 1998, now renamed VCE), and the college population as a whole also included many older students on "community" courses. Although the descriptive statistics of the sample and the wider population are broadly similar, any conclusions about the wider population must bear in mind the sample size and the differences identified in this chapter.

In 1998 a large proportion of students reported some access to a computer at home, and this had increased by 2006. Fewer students had sole access to a computer in the home, the proportion remaining broadly similar from 1998 to 2006. A small number of students reported that they accessed a computer in a public library but the number accessing a computer in other locations outside college was negligible. When broken down by gender categories, the picture was broadly similar to the sample as a whole. For those ethnic groups where numbers were large enough to make a comparison meaningful, there was some variation from the population as a whole but not enough to discern a pattern. Once the sample as a whole was broken down between all ethnic categories, even the more numerous ethnic categories had small sizes, making it unsafe to draw any conclusions, and so these were aggregated into larger categories. Almost all students were in the same age bracket of 16-19. As no clear differentiation emerges amongst the personal data categorisations of the sample, it can be assumed in the analysis chapter that any conclusions of interest to emerge concerning access to computers outside college apply irrespective of age or ethnicity.

The differences between the sample and the wider student population, particularly in terms of reported access to a computer outside college, mean that conclusions about the wider population are subject to those differences. For instance, conclusions about the relationship between ethnicity and the effectiveness of the use of IT resources need to bear in mind that in the study college the population was atypical. As the principal purpose of this study is to set out and explore the application of methods used in Individual Time-Data analysis, limitations on generalisation do not detract from exploring the method, as long as the differences are noted.

Differences between the sample population and the general population may indeed suggest avenues for further study. Of particular interest is the greater access to IT resources outside college for the students in the sample than in the greater population. This is explored further in Chapter 5 in the discussion on Research question 2 – "Can the interrelationship between engagement in IT based activities and performance be distinguished from the general hard work factor demonstrated by greater engagement in all activities?”

4.3.2 The student-subject data set

A comparison has been made between the student-subject data set and the student data set which showed that the two were broadly similar. However, the breakdown of the student-subjects data set into different student-related variables (gender, age and ethnicity) displayed some variability, indicating the distorting effect where students of one ethnic group reported on more courses studied than others.

The student-subject data set was categorised by the faculty in which the course was located. These data were then reviewed by age, ethnicity, gender and computer access and then compared with national statistics. Although there were differences with the national figures for gender, there was no clear pattern and this difference was probably accounted for by the small sample size of the study. It has already been noted that it may not be possible to apply conclusions drawn from the ethnicity data to the national population due to the dissimilarity between the sample, the college as a whole and the national breakdown. Almost all the students in the study were in the 16-19 age bracket and so we should not read too much into differentiation by age, although some variation between subjects was noted. The figures describing access to a computer outside college did show some interesting variations which point to areas on which the statistical analysis may shed light, for example, in 1998, more business studies students reported access to a computer outside college other than at home, and a greater number of IT students reported sole use of a computer at home than for the sample as a whole.

The student subject data set also recorded the amount of time students spent in the different activities they reported on. In general, male students reported that they spent more time overall in all activities, as did students from Asian ethnicity categories, although the greater hours can be attributed to a small number of students who spent a much greater amount of time. No clear pattern emerged over age. It is interesting to note that those who reported sole access to a computer at home also reported higher overall time spent in all activities. When these figures were broken down into separate activities, there was no clear pattern discernable in the gender and age variables; however, students from a South Asian background reported more time spent in IT based activities. Those with access to IT resources at home reported a greater amount of time spent in IT based activities outside college.

Looking at the descriptive statistics of the student-subject data set, no clear patterns emerge, suggesting that these will not affect the outcome of the statistical analysis. Where comparisons were possible with national figures, no wide variance was noted, suggesting that the results of this study can be applied generally to the wider population.

This section suggests the possibility that the there may be an interrelationship between performance and the course studied, access to IT resources and the different amounts of time spent in different activities, especially IT activities,.This is investigated further in the next chapter.

5 STATISTICAL ANALYSIS

5.1 Questions, hypotheses and variables

The general thesis explored in this study is that educational strategies which employ IT resources are more effective than those relying on non-IT based resources and, in Chapter 2, I arrived at a set of research questions for the study. In Chapter 3, I identified the sources of data which could be used in the analysis. Having undertaken, in Chapter 4, a descriptive review of the data collected, consideration must now be given to that analysis.

5.1.1 The relationship between IT resource use and performance

The first research question to be considered was:

> Does engagement in IT based activities have a discernable interrelationship with improved performance by students?

The hypothesis was that there is a stronger interrelationship between engagement in IT based activities and the performance of students than non-IT based activities. If this was the case there are implications for resourcing within colleges and for the structure of pedagogical practice.

Consideration of this question involved the following data variables:

- Performance data (value added score) – the model needs to look at the relationship between different factors and performance, and so the value added score is the dependent variable. The value added model used does not incorporate covariates. The relationship between these covariates, performance and IT are considered separately in the subsequent questions.
- Use of IT based resources (this can be broken up into sub-categories if necessary)

After investigating the first, overarching, research question, further issues were addressed by the subsequent questions. The second question probed further into apparent effectiveness:

> Can the interrelationship between engagement in IT based activities and performance be distinguished from the general hard work factor demonstrated by greater engagement in all activities?

The hypothesis for this question was that there are attributes of IT resources which make them more effective learning tools irrespective of the amount of "hard work" the student undertakes. This was tested by comparing high use of IT based resources with two measures of general "hard work". The first of these is the amount of time spent in IT based activities which are largely the responsibility of the student – work in college outside class and work outside college (also referred to in the following analysis as self study). If it is shown that students achieving the best performance spend a greater proportion of their undirected self-study time working with IT resources, then it can be suggested that it is the use of IT which is contributing to the student's performance. In contrast, if the best performing students spend more of their self-study using non-IT resources, then it may be that it is this which is contributing to their performance. If is shown that the high performance is not proportional to total time worked, but to greater use of IT resources, then it is possible that it is the use of IT rather than "hard work" alone which is contributing to the performance.

Consideration of this question involved the following data variables:

- The use of IT based resources
- The use of non-IT resources
- The time spent on work at home.

5.1.2 The relationship between the curriculum and performance

The third research question came under the heading of curriculum

> Is the relationship between participation in IT activities and performance affected by choice of subject?

The hypothesis here was that higher performance by students is related to their choice of subject. This relationship needs to be distinguishable from any interrelationship between the use of IT resources and performance.

This question added choice of subject to the model as an independent variable. This is a categorical variable. Dummy variables were used to incorporate this into a multiple regression analysis.

5.1.3 Students' prior learning and experience in the wider community

The fourth and fifth questions came under the heading of building on students' prior experience and learning. The fourth question was:

> Is the relationship between participation in IT activities and performance affected by previous experience of using IT resources?

The hypothesis was that increases in performance related to the efficiency of IT resources are greater for students who have had access to IT resources prior to coming to college. If IT use is a more effective method of learning than non-IT use, those who have the experience to be able to make use of IT resources have a greater chance of higher performance. If the hypothesis is correct, this has implications for access to education resources and, as with the next question, the issue is whether the relationship of IT provision at college to performance can be distinguished from that of IT resources not provided by the college.

This question contributed an independent variable representing possession of an ICT qualification from school (or other previous educational institution) and measured by a yes/no dummy variable. This can be taken as proxy for prior experience as this was objective information which could be obtained from the college's MIS.

It should be noted that this variable related to the student data set, rather than the student-subject data set, and so was repeated for each record a student had in the student-subjects database.

The fifth question was related to this:

> Is the relationship between participation in IT activities and performance affected by access to a computer outside college?

The hypothesis for this question was that increases in performance related to the efficiency of IT resources are greater for students who have access to IT resources outside college. To verify the hypothesis it needs to be shown that those with access to IT resources outside college - and using it for college work - are more likely to achieve a higher value added score. The goal of building on students' experiences outside college (using resources not provided by the college) needs to be balanced against the goal of providing resources which will help them learn. If the hypothesis is affirmed, then the college needs to assess whether they have struck the right balance.

This question used access to IT resources as a categorical variable. In the statistical analysis this was aggregated into a single categorical variable of access or no access outside college.

5.1.4 Other factors

In order to isolate the relationship between the use of IT and performance, the remaining questions sought to distinguish various other factors which may relate to performance. The sixth question asked:

> What is the relationship between student gender and performance?

The hypothesis being tested was that higher performance can be explained by gender-differences. The seventh question similarly asked:

> What is the relationship between student ethnicity and performance?

This tested the hypothesis that higher performance can be explained by differences in ethnicity. The interrelationship between these variables was also explored through a multiple regression analysis, which will be discussed further below.

These questions provided the two variables – gender and ethnicity and were used as categorical independent variables in the model.

5.1.5 The attributes of the variables used

5.1.5.1 Attributes

I have listed the variables used in the study in Table 5-1. Not all of them were used in the same run of the analysis model in the SPSS software used. If the aggregate IT/non-IT use variable was used at the same time as the sub category (e.g. time spent in IT resources in college outside class) problems of co-linearity arose. However in each run of the analysis there was a "slot" for an IT based time data variable and a non-IT based time variable.

Table 5-1: Variables used in the study

Variable	Descriptive categorisation	Regression Type		Number Type	
		Dependent	Independent	Continuous	Categorical
1) Value added Score	Performance variable	Y		Y	
2) Time spent using IT resources	Time data variables (IT based) aggregated as total time spent in IT based activities		Y	Y	These, once aggregated, have been categorised into quartiles
3) Time spent in use of IT resources in the classroom			Y	Y	
4) Time spent in use of IT resources in college outside class			Y	Y	
5) Time spent in use of IT resources outside college			Y	Y	
6) Time spent using non-IT resources	Time data variables (non-It based) aggregated as total time spent in non-IT based activities		Y	Y	
7) Time spent in use of non-IT resources in the classroom			Y	Y	
8) Time spent in use of non-IT resources in college outside class			Y	Y	
9) Time spent in use of non-IT resources outside college			Y	Y	
10) Faculty category	Course variable		Y		Y
11) Possession of a prior IT qualification	Input score variable		Y		Y
12) Access to a computer outside college	Computer access variables		Y		Y
13) Gender	Student variables		Y		Y
14) Ethnicity			Y		Y

NOTES:
The Value Added Score is derived from the actual UCAS points minus the predicted UCAS points gained by the student. The predictions were derived from DfES regression lines. The scheme of UCAS points used changed during the course of this study, and so for the sake of consistency the old scheme was used - see Appendix 4a for values. The value added score is measured in Residual UCAS points.

It was necessary to aggregate some of the time-data variables in some of the analyses. For example: addressing question 2, the variables: "time spent in use of non-IT resources outside college" and "time spent in use of IT resources outside college" were aggregated into a new variable of time spent in college work outside college.

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5.1.5.2 Note on the time data variables

Time data variables were categorised into four groups representing the four quartiles.

This was done by SPSS automatically – as described in the following extract:

> Categorise Variables converts' continuous numeric data to a discrete number of categories. The procedure creates new variables containing the categorical data. Data are categorised based on percentile groups, with each group containing approximately the same number of cases. For example, a specification of 4 groups would assign a value of 1 to cases below the 25th percentile, 2 to cases between the 25th and 50th percentile, 3 to cases between the 50th and 75th percentile, and 4 to cases above the 75th percentile.
>
> (SPSS Help File)

This created categories as presented in Table 5-2 for the 1998 data and 5-3 for 2006 data:

Table 5-2: 1998 data set - categorisation of time data variables by quartiles

	Category	Lowest value	Highest value in hours excluding outliers	Mean value in hours excluding outliers
Sum of IT activities	1	0.00	0.00	0.00
	2	0.17	0.69	0.44
	3	0.71	3.02	1.75
	4	3.13	15.00 See Note 3 Below	7.08
Sum of non- IT activities	1	0.00	2.65	0.82
	2	2.73	5.14	4.07
	3	5.24	8.21	6.61
	4	8.34	20.00 See Note 4 Below	9.71
All work outside college	1	0.00	0.40	0.03
	2	0.43	1.63	0.97
	3	1.64	2.88	2.26
	4	2.92	10.00 See Note 5 Below	3.87

NOTES:

1) Values indicated as 0 are derived from an indication on the questionnaire that the student meant that they spent no time in that activity, rather than merely neglecting to provide any indication (i.e. the value is a genuine zero and not a null value). Indications of a zero value on the questionnaire included "0", a line or dash, and "n/a".
2) Outliers are defined here as those values outside the normal trend line, greater than three standard deviations from the mean
3) I have excluded 2 values as outliers from the range quoted, one at 19.8 and one at 19.1. These have been retained in quartile 4 in the analysis – see Appendix 4b for illustrative scatter graph.
4) I have excluded 5 values as outliers from the range quoted. These ranged from 20.00 to 26.90. These have been retained in quartile 4 in the analysis – see Appendix 4b for illustrative scatter graph.
5) I have excluded 5 values as outliers from the range quoted. These ranged from 10.00 to 14.60. These have been retained in quartile 4 in the analysis – see Appendix 4b for illustrative scatter graph.

This table shows the highest and lowest values in each of the categories created by SPSS for the 1998 data set and gives an indication of the range of the categories. The minimum and maximum values in the ranges show that students spent more time in non-IT based activity than in IT activity. The majority of time spent in class was recorded by the students as non-IT based activity. The lower quartile for IT based activities consists entirely of those students who report no IT based activity.

Table 5-3: 2006 data set - categorisation of time data variables by quartiles

	Category	Lowest value	Highest value in hours excluding outliers	Mean value in hours excluding outliers
Sum of IT activities	1	0.00	0.00	0.00
	2	0.02	2.00	1.09
	3	2.02	7.00	4.39
	4	7.02	32.00 See Note 3 Below	12.93
Sum of non- IT activities	1	0.00	0.00	0.00
	2	0.02	1.00	0.63
	3	1.02	4.00	2.68
	4	4.02	20.00 See Note 4 Below	7.51
All work outside college	1	0.00	0.00	0.00
	2	0.02	1.00	0.70
	3	1.02	4.00	2.45
	4	4.02	29.00 See Note 5 Below	8.20

NOTES:

1) Values indicated as 0 are derived from an indication on the questionnaire that the student meant that they spent no time in that activity, rather than merely neglecting to provide any indication (i.e. the value is a genuine zero and not a null value). Indications of a zero value on the questionnaire included "0", a line or dash, writing "n/a".
2) Outliers are defined here as those values outside the normal trend line. greater than three standard deviations from the mean
3) I have excluded 8 values as outliers from the range quoted, These ranged from 32.00 to 68.00. These have been retained in quartile 4 in the analysis – see Appendix 4b for illustrative scatter graph.
4) I have excluded 6 values as outliers from the range quoted, one ranged from 20.00 to 40.00. These have been retained in quartile 4 in the analysis – see Appendix 4b for illustrative scatter graph.
5) I have excluded 4 values as outliers from the range quoted, ranged from 29.00 to 81.00. These have been retained in quartile 4 in the analysis – see Appendix 4b for illustrative scatter graph.

This table shows the highest and lowest values in each of the categories created by SPSS for the 2006 data set. It shows that students spent more time in IT based activities than in non-IT activities. This is a reversal of the situation in 1998. The information provided on the questionnaire by some students in 2006 indicated that they spent no time in class in either IT or non-IT activity for a particular subject, but that they spent time in other activities both IT and non-IT based. As this data was taken from the questionnaire based on a positive indication that no time was spent (e.g. a zero, a line or dash or writing "n/a") rather than the mere absence of data, the conclusion must be that these student were either not attending class, there was no scheduled time for that class or that the information they provided was inadequate. This was borne in mind later, when considering the clarity of the picture described by the analysis. When the analysis was re-run without these records, there was no noteworthy difference in the results shown.

5.2 Model Options

5.2.1 Model options available

A model needed to be produced for the statistical analysis of these variables which allowed the consideration of the research questions.

The following statistical techniques were used.

1) ANOVA - to establish the relationship of the variables studied to performance;
2) simple correlation between two continuous variables; and
3) multiple regression analysis for a continuous dependent variable and two or more continuous independent variables. This can incorporate categorical variables as dummy variables.

A multiple regression analysis is advantageous as it incorporates all the variables into one model, so that the effects of all the independent variables can be seen on the dependent variable.

The three techniques were used in the model as a three stepped approach in the order ANOVA, correlation then regression. For the third step, a two-stage multiple regression model was used to separate those personal factors which were related to the student, and remained the same in all the subjects a student was studying, and those which varied across the subjects. It may be that the variability in performance scores can be attributed to the patterns of study for students across the A-levels they take, or it may be a attributable to a factor such as gender which, relating to the students, is common to all the subjects studied. The data for the model represents two distinct levels of data: student related data and student-subject related data. A two stage model gave the ability to control for student related data (age, ethnicity etc.) and then looked at how the student-subject related data affected the model separately.

5.2.2 Analyses conducted

5.2.2.1 ANOVA

In order to investigate the relationship between the variables and performance, a one way analysis of variance (ANOVA) was carried out. This test analysed the variability in scores between different groups, comparing it with the variability within groups. The groups in this case were the categories into which the records in the data set were divided, which were treated as variables or dummy variables.

An ANOVA analysis run using SPSS software reports results under the following headings:

- **Descriptive data**. A comparison of the mean values is carried out, which can suggest relationships to the value added score for the different categories.
- **Test of homogeneity of variances:** The analysis assumes homogeneity of variances, and a test is conducted to check whether this is the case. If it is not, then this has implications for using parametric or non-parametric tests.
- **The ANOVA table:** In each of the analyses, this table sets out the mean difference in value added score (the unit of measurement being residual

UCAS points). Differences which were statistically significant are identified and the effect size of the difference is noted.

The following three analyses were carried out.

- **Analysis of variance between faculties.** Courses were categorised, for the purposes of this study, by the faculty in which they were studied (faculty category). The aim of this first analysis was to explore whether there was a relationship between faculty category and the value added score. The analysis was set up with the value added score as the dependent variable and faculty as the independent variable.
- **Analysis of variance between categories of time spent in IT based activities.** The aim of this analysis was to explore whether there was a relationship between time spent in IT activities and the value added score. The analysis was set up with the value added score as the dependent variable and the quartile of time spent in all IT activities as the independent.
- **Analysis of variance between categories of time spent in non-IT based activities.** A similar analysis of variance to that above was carried out for non-IT based activities.

All three ANOVA analyses carried out for the 1998 data set showed a violation of the test of homogeneity of variances, suggesting that non-parametric methods ought to be used for the other analyses. For the 2006 data set this was not the case, with the analyses showing a significance indicating homogeneity of variance.

5.2.2.2 Correlational analysis

In order to explore further the relationships between the variables and the value added score, correlation grids were produced.

Two factors emerged which suggested that parametric statistical methods might not be the most reliable. These are identified in 5.2.2.2.1 and 5.2.2.2.2 below. In the context of correlational analysis this meant that Spearman's rather than Pearson's correlation should be used. I have therefore used as a basis for my analysis, a grid of non-parametric correlations (Spearman's) with the value added score. These tables can be seen in Appendix 4d.

5.2.2.2.1 Variance from a normal distribution curve

Before entering the data into the analytical model, it was necessary to consider whether there needed to be a transformation of the data.

To do this, histograms of the variables were produced and examined. Most of the variables in this analysis were categorical and so dummy variables were used. A variety of transformations were tested but made little difference to the skewness of the data. The exception was the value added score in the 1998 data set (see Appendix 4c) which was skewed to the left. This could potentially be transformed by taking the square root of each piece of data to show a distribution to a normal distribution curve. This transformed the skewness of the distribution from 1.16 to 0.12 and the kurtosis from 1.28 to – 0.78.
For the 2006 sample, there was no obvious skew which could be compensated for by the transformations discussed here.

It was decided that it was better to use non-parametric methods such as Spearman correlations rather than rely on transformations which distance us from the original data.

5.2.2.2.2 ANOVA - violation of the rule of homogeneity of variance

In 1998, for each of the analyses carried out, the significance figure read as 0.00 indicating that there has been a violation of the rule of homogeneity of variance between the categories in the analysis. Although most statistical tests are robust enough to withstand a violation of this assumption, the fact of the violation suggests that non-parametric statistics be used to ensure a more accurate picture. The 2006 data gave statistically significant results meaning that parametric methods were available for the 2006 data, however as they are not available for the 1998 data, non-parametric methods needed to be considered for the 2006 data, in order to make an adequate comparison with the 1998 data.

5.2.2.3 Multiple regression analysis

Having looked at all the relationships between variables on a one to one basis, a multiple regression analysis can give an overall picture of how the variables relate to the value added score.

Using a two stage hierarchical model, I controlled first for student level variables (ethnicity, gender, possession of an IT qualification on entry, computer use) before building in the student-subject level variables (time spent in different activities).

5.3 Analysis – consideration of the research questions

5.3.1 Consideration of question 1

Does engagement in IT based activities have a discernable interrelationship with improved performance by students?

The 1998 analyses produced evidence to suggest that the hypothesis for this question – that there is a stronger interrelationship between engagement in IT based activities and the performance of students than non-IT based activities - is confirmed. Students who spent most time engaged in IT based activities were far more likely to gain a higher value added score. The picture for the 2006 data was less clear, but suggested that there was a negative relationship between increases in time spent in IT based activities and a higher value added score. This picture is built up from the three stages of the analysis set out below.

5.3.1.1 ANOVA – time spent in IT and non-IT based activities

An ANOVA test was run with value added score as the dependent variable and the category of total time spent in IT or non-IT based activities for each of the two data collections as independent variables.

For the 1998 data collection, the mean value added score was generally greater the more time was spent on IT based activities. This was also true of non-IT based activities, but this was less pronounced. In 2006 the opposite was true. Although the picture was less clear, the greater the mean time spent on IT activities, the lower the mean value added score. The same picture emerged for non-IT based activities. This was also true when those students who reported no time in either IT or non-IT in class were removed from the analysis.

As has been noted above, the 1998 ANOVA tests all showed that the data displayed a violation of the rule of homogeneity of variance and although most statistical tests are robust enough to withstand a violation of this assumption, caution needs to be exercised in drawing conclusions from parametric results such as the ANOVA test on mean value added score. Having run the ANOVA test, the results may indicate a tendency which can be confirmed by the non-parametric methods followed in the later analysis. This was less of a consideration for the 2006 data as the rule of homogeneity of variance was not violated. Table 5-4 shows the ANOVA descriptive data for this analysis.

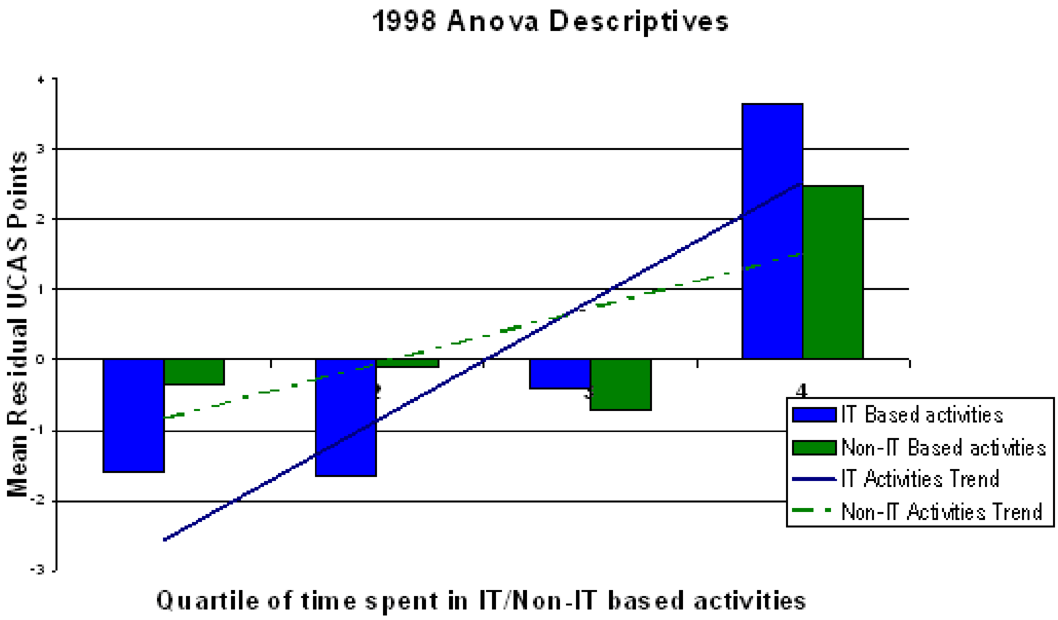
Table 5-4: ANOVA descriptives - IT & non-IT based activities

			IT based activities		Non-IT based activities	
Category of resource use			Range of values	Residual UCAS Points	Range of values	Residual UCAS points
1998	1	Lower quartile	No IT use	-1.6	0.00 to 2.70 hours use	-0.3
	2	↑	0.17 to 0.70 hours use	-1.7	2.70 to 5.20 hours use	-.09
	3	↓	0.70 to 3.02 hours use	-0.4	5.20 to 8.25 hours use	-0.7
	4	Upper quartile	Over 3.02 hours use	3.6	Over 8.25 hours use	2.5
2006	1	Lower quartile	No IT use	6.2	No non-IT use	6.4
	2	↑	0.02 to 2.00 hours use	6.1	0.02 to 1.00 hours use	5.6
	3	↓	2.02 to 7.00 hours use	4.3	2.02 to 4.00 hours use	5.4
	4	Upper quartile	Over 7.02 hours use	5.3	Over 4.02 hours use	4.5

NOTE:
The residual UCAS scores represent the difference between the predicted score and the actual score in UCAS Points (as measured on the scale used in 1998). An A-level grade equates to 2 points; a negative score indicates that a student performed lower than their prediction.

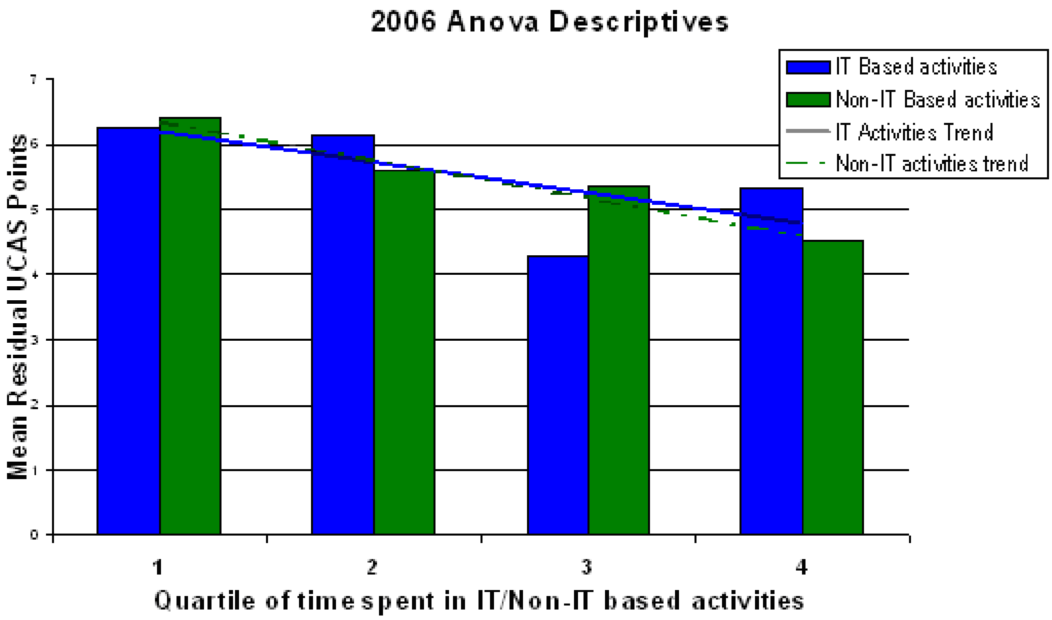
In the table above it is clear that in 1998 a tendency was shown that the more time was spent in non-IT/IT based activities - represented by each higher category - the greater the value added score (measured in residual UCAS points). This is shown more clearly in Figure 5-1.

Figure 5-1: ANOVA descriptives - IT & non-IT based activities (1998)



The picture revealed by the 2006 data is different. Rather than confirming the trend it appears to show the opposite: that when more time is spent in IT based activities, the students' performance is worse.

Figure 5-2: ANOVA descriptives - IT & non-IT based activities (2006)



Although the trend for the 2006 data collection was a reversal of the 1998 one, it is important to note that the mean value added score for the highest quartile in 1998 (3.63) was still lower than the lowest mean score for any quartile in 2006 (4.28). This may be evidence of a general improvement in performance across the college and nationally. Higher value added scores would be expected in the sample reflecting better scores nationally, as the same regression line was used in the value added calculation in 1998 and 2006.. This is also discussed later with reference to the college's improving inspection ratings; however, it also suggests the possibility that the relationship between IT based activities and value added scores is stronger when performance is not as good. The dips in the middle categories suggest that for both IT and non-IT the relationship between time spent in activities and performance is not linear. This result was more pronounced for the non-IT activities. Looking at the 2006 data, the trend for non-IT activities is for a steady reduction in the mean value added score for each successive time quartile. For IT based activities there is a dip in the third quartile. In 2006, there was some doubt as to the reliability of the reporting of time in class by students with some students reporting no time spent in class in either IT or non-IT. When these students were removed, the pattern that showed a slight decrease in performance as more time is spent in either IT or non-IT activities was still evident. These adjusted quartiles are set out below:

Quartile	IT	Non-IT
1	5.9	5.5
2	4.5	4.5
3	6.4	6.6
4	4.3	4.4

The only major difference here is that the mean value added score for the third quartile for IT changed from having the lowest value (4.3) to the highest (6.4). This does not reverse the picture already described, but slightly diminishes the negative trend.

In 1998, the gradient of the trend line for the increase in value added scores was greater for IT based activities categories than for non-IT based activities suggesting that the relationship of IT based activities to performance was greater. In 2006 the gradient for each type of activity was broadly similar. It should be noted that in 1998, excluding outliers, the highest value for time spent in IT activities (15 hours) was greater than the highest value for time spent in non-IT based activities (11 hours). It is possible that the increase in value added score for those students who spend most time in IT based activities, might be accounted for by the actual increase in total time spent i.e. the increase is attributable to hard work and not IT use. This is considered under the second research question below. In 2006 the highest value for time spent in IT was again higher than for the time spent in non-IT based activities, although there was no corresponding increase in value added score.

The ANOVA analysis' main output was the comparison of the means of the various categories. The following table is an extract from the SPSS ANOVA multiple comparisons table (see Appendix 4e) comparing the means of the various categories in a matrix. The table highlights the differences in the means between the upper quartile category for both IT and non-IT based activities and the other categories.

Table 5-5 reinforces the picture of the 1998 data already described. In 1998, the relationship between IT based activities and performance appeared stronger than with non-IT based activities.

Table 5-5: ANOVA multiple comparisons table - IT & non-IT based activities

Category			IT based activities (quartiles)					Non-IT based activities (quartiles)				
			Mean VAS	Mean difference In VAS (residual UCAS points)				Mean VAS	Mean difference In VAS (residual UCAS points)			
				1	2	3	4		1	2	3	4
				Lower quartile ←		→ Upper quartile			Lower Quartile ←		→ Upper Quartile	
1998	1	Lower quartile	-1.6		0.5	-1.2	**-5.2**	-0.3		0.6	0.4	**-2.8**
	2	↑	-1.7	-0.5		-1.3	**-5.3**	-0.9	-0.6		-0.2	**-3.4**
	3	↓	-0.4	1.2	1.3		**-4.0**	-0.7	-0.4	0.2		**-3.2**
	4	Upper quartile	3.6	**5.2**	**5.3**	**4.0**		2.5	**2.8**	**3.4**	**3.2**	
2006	1	Lower quartile	6.2		-0.2	**-0.2**	-0.2	6.4		-0.2	**-0.2**	-0.2
	2	↑	6.1	0.2		-0.1	0.0	5.6	0.2		-0.0	-0.0
	3	↓	4.3	**0.2**	0.1		0.1	5.4	**0.2**	0.0		0.0
	4	Upper quartile	5.3	0.2	-0.0	-0.1		4.5	0.2	0.0	-0.0	
Figures significant at the 0.05 level are marked in bold												

In 1998, the range of differences between the upper quartile (quartile 4) and the other categories (-2.8 to 3.4 residual UCAS points) was smaller for non-IT based activities and lower in value, compared with 4.0 to 5.3 for IT activities. The range between the other categories is also slightly smaller -0.2 to 0.6, compared with 0.5 to 1.3 for IT activities. The data for 2006 shown in this table is less clear. The difference between the mean value added score for each quartile is largely consistent between the quartiles. This difference is also much smaller than in 1998 - rising from -0.2 to +0.2 in the case of both IT and non-IT activities.

A further piece of evidence is the effect size based on the Eta-squared statistic (sum of square between groups divided by total sum of squares). In 1998 this is larger for IT based activities, at 0.25, than for non-IT based activities, at 0.09 (based on Cohen's classification (Cohen, 1988 - cited in Pallant, 2001). The Eta Squared statistics showed a negligible effect size for both IT and non-IT based activities in 2006 (both less than 0.02). This negligible effect size is a corroboration of the picture which emerged from the other ANOVA statistics that the relationship between participation in IT based activities and value added score was not strong.

5.3.1.2 Correlation analysis

The patterns which emerged from the ANOVA analysis. were confirmed by the correlation analysis.

For the reasons stated above, the Spearman correlations were more reliable than the parametric alternative (Pearson). Extracts of the Spearman table are set out in table 5-6 (see Appendix 4d for the full table).

Table 5-6: Spearman correlations - Correlation between quartile of IT based activity and value added score

			IT based activities (quartiles)				Non-IT based activities (quartiles)			
			1	2	3	4	1	2	3	4
			Lower quartile (Least use)	←	→	Upper quartile (Most use)	Lower quartile (Least use)	←	→	Upper quartile (Most use)
1998	Correlation coefficient	Value added score	**-0.26***	-0.12	-0.03	**0.40***	-0.06	-0.03	-0.12	**0.21***
		Significance	0.00	0.09	0.67	0.00	0.43	0.67	0.09	0.00
2006	Correlation coefficient	Value added score	0.09	0.00	-0.09	-0.00	0.09	-0.01	-0.03	-0.05
		Significance	0.11	0.99	0.10	0.94	0.11	0.80	0.56	0.36

Notes
* Correlation is significant at the 0.05 level (2-tailed).

This table show the correlations between each of the four quartiles of IT use and value added score. Correlations can range from 1.0 which indicates a strong positive correlation to -1.0 indicating a strong negative correlation. The stronger the positive correlation the greater likelihood there is a positive relationship between the two variables, e.g. the greater the amount of time spent in an activity, the greater the likelihood of obtaining a higher value added score. Where a correlation is strong but not significant, then the indication is less reliable.

The correlations for 1998 indicate a positive relationship between the time spent in IT based activities and higher value added scores. The correlation between students who spend most time in IT activities (upper quartile of IT use) and value added score is 0.40, a positive relationship. The correlation between those who spend the least time in IT activities (the lower quartile) and value added score is negative at minus 0.26. This relationship is strongest at the ends of the range; with those who spent least time in IT based activities being least likely to get higher value added scores and those who spent most time in IT based activities being more likely to achieve higher value added scores. For those in the middle of the range, the relationship of time spent in IT based activities to performance was weaker. In 2006, there were no strong correlations, either positive or negative, between the value added score and the time spent in any of the activity categories. This was also true when students who reported no time spent in class in either IT or non-IT were removed from the calculation.

In 1998, there were significant Spearman correlations with value added scores in the lower quartile of IT use (no IT use - correlation: -0.26; significance 0.00) and the upper quartile (over 3.02 hours use - correlation 0.40; significance 0.00). This suggests that there may be a relationship between a low level of participation in IT based activities and poor performance, as measured by the value added score; and also a relationship between high IT use and high performance. The two middle quartiles are not indicated as statistically significant and do not show a strong correlation.

With regard to non-IT use, the correlation between those who spend the most time in non-IT based activities (the upper quartile) and value added score is slightly weaker at 0.21 than for IT based resources (0.40), suggesting that although time spent in any activity increases the chances of a greater value added score, there is a stronger association between time spent in IT activities and value added score than for time spent in non-IT activities. The only statistically significant correlation with value added score is between the upper quartile of non-IT use (over 8.25 hours use: correlation 0.21, significance 0.0), the other categories having a range of correlations between -0.06 and -0.12. In 2006 there were no correlations which were shown as statistically significant at the 0.05 level.

As has been noted, while parametric techniques (Pearson correlation) may not be reliable with these data, the Spearman correlation pattern is repeated by the Pearson correlations.

5.3.1.3 Multiple regression analysis

The multiple regression analysis also corroborates the evidence produced by the ANOVA and the correlational analysis. The 1998 data points to the upper quartile of IT use as being both a statistically significant and important coefficient. This was not repeated in 2006.

The importance of the different variables can be shown in the coefficients table. The key coefficients have been extracted from the SPSS output and displayed in the table 5-7

Table 5-7: Multiple regression analysis coefficients

Variable	Coefficient	
	1998	**2006**
Quartile of IT use 2	1.86	1.40
Quartile of IT use 3	2.51	-1.59
Quartile of IT use 4	**6.15**	0.76
Quartile of non-IT use 2	-1.98	-1.97
Age at survey	**1.74**	Excluded
Quartile of non-IT use 3	-1.42	-0.38
Quartile of non-IT use 4	1.13	-2.55
Faculty category 1 (dummy)	Excluded	0.18
Faculty category 2 (dummy)	0.11	2.13
Faculty category 3 (dummy)	-3.20	**3.50**
Faculty category 4 (dummy)	Excluded	**4.64**
Faculty category 5 (dummy)	-1.76	2.31
Faculty category 6 (dummy)	-3.69	-1.04
Faculty category 7 (dummy)	-3.60	**4.98**
Faculty category 9 (dummy)	-0.27	Excluded
Faculty category 10 (dummy)	5.00	Excluded
IT input score	-0.23	**-9.08**
NOTES 1) Data taken from SPSS model 2 of the two stage analysis 2) Those variables marked “excluded” were excluded by the SPSS analysis 3) Those coefficients significant at the 0.05 level are marked in **bold**		

This table shows that in 1998 the only two variables which were statistically significant were age and the upper quartile of IT use (over 3.02 hours use) – a coefficient of 6.15. Age will be discussed under research question 6, but it should be noted that the variable with the highest value coefficient is the upper quartile of IT use. This appears to confirm the picture of high IT use being an important factor in higher achieving a higher value added score. In 2006, the coefficients for more of the variables were statistically significant. Of the four significant coefficients, three related to the course studied. These were positive suggesting that a positive relationship between course studied and the student’s value added score. The implications of this will be explored in more detail in response to research question 3. The relationship between possession of an IT qualification and value added score appeared to be seemed to be strongly negative (-

9.08). The relationship between participation in IT based and non-IT based activities and value added score did not show as being statistically significant, and the value of the coefficient was lower in 2006 than in 1998; however, the coefficient for the upper quartile of IT use was higher than the other IT use quartiles and the non-IT use quartiles. The picture in 2006 was less clear, and, by ranking the coefficients for each year, as is shown in table 5-8, no consistent pattern emerges.

Table 5-8: The coefficients ranked

1998		**2006**	
Variable	**Coefficient**	**Variable**	**Coefficient**
Category of IT use 4	**6.15**	Faculty category 7 (dummy)	**4.98**
Faculty category 10 (dummy)	5.00	Faculty category 4 (dummy)	**4.63**
Category of IT use 3	2.51	Faculty category 3 (dummy)	**3.50**
Category of IT use 2	1.86	Faculty category 5 (dummy)	2.31
Age at survey	**1.74**	Faculty category 2 (dummy)	2.13
Category of non-IT use 4	1.13	Category of IT use 2	1.40
Faculty category 2 (dummy)	0.11	Category of IT use 4	0.76
IT input score	-0.23	Faculty category 1 (dummy)	0.18
Faculty category 9 (dummy)	-0.27	Category of non-IT use 3	-0.38
Category of non-IT use 3	-1.42	Faculty category 6 (dummy)	-1.04
Faculty category 5 (dummy)	-1.76	Category of IT use 3	-1.59
Category of non-IT use 2	-1.98	Category of non-IT use 2	-1.97
Faculty category 3 (dummy)	-3.20	Category of non-IT use 4	-2.55
Faculty category 7 (dummy)	-3.60	IT input score	**-9.08**
Faculty category 6 (dummy)	-3.69	Faculty category 9 (dummy)	Excluded
Faculty category 4 (dummy)	Excluded	Faculty category 10 (dummy)	Excluded
Faculty category 1 (dummy)	Excluded	Age at survey	Excluded

5.3.1.4 A breakdown of activities

The same three stage analysis was repeated, breaking down IT and non-IT based activities into sub-categories based on the location in which they occur. The aim was to establish whether the same picture emerges for the IT and non-IT categories, and whether any particular activity emerges as having a stronger relationship to performance. In breaking down the activities like this, it may be possible to hypothesise about the relationship between the attributes of these activities help and value added scores.

The IT and non-IT activity data analysed above was aggregated from a detailed breakdown of activities as set in Table 5-9.

Table 5-9: Individual activities

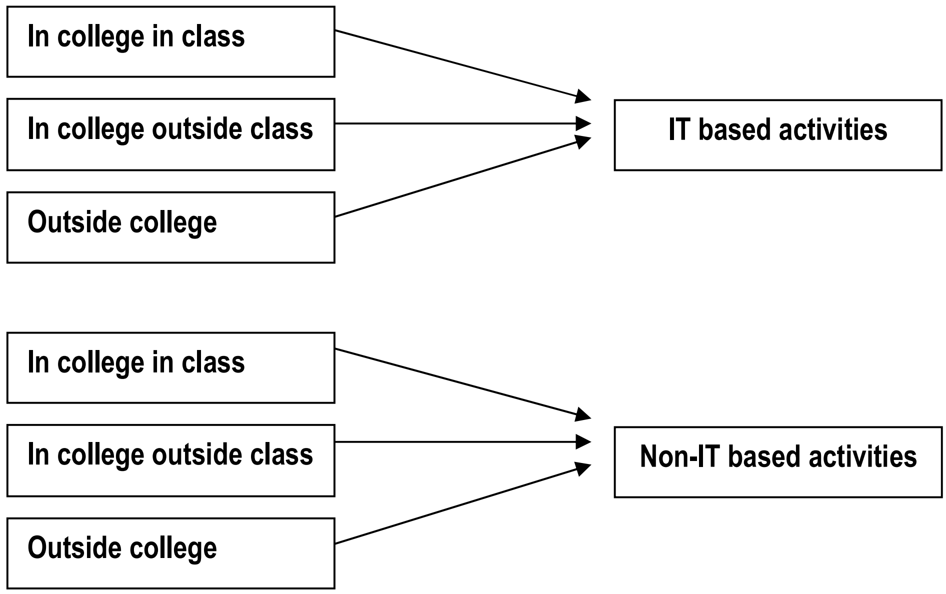
IT Based?	Activity	Location	Mean time reported for this activity per subject (Hours) 1998	2006
Computer based activities	Word-processing	Time spent in class:	0.5	0.4
		Time spent in college outside class (e.g. in the library):	0.4	0.5
		The time you spend outside college (e.g. at home)	0.5	0.7
	Spreadsheets	Time spent in class:	0.2	0.1
		Time spent in college outside class (e.g. in the library):	0.1	0.1
		The time you spend outside college (e.g. at home)	0.1	0.1
	Desk top publishing	Time spent in class:	0.1	0.1
		Time spent in college outside class (e.g. in the library):	0.1	0.1
		The time you spend outside college (e.g. at home)	0.1	0.1
	Information on a CD ROM	Time spent in class:	0.1	0.1
		Time spent in college outside class (e.g. in the library):	0.1	0.1
		The time you spend outside college (e.g. at home)	0.1	0.1
	Information on the Internet	Time spent in class:	0.1	0.4
		Time spent in college outside class (e.g. in the library):	0.1	0.5
		The time you spend outside college (e.g. at home)	0.1	0.5
	E-mail	Time spent in class:	0.0	0.1
		Time spent in college outside class (e.g. in the library):	0.1	0.1
		The time you spend outside college (e.g. at home)	0.0	0.1
	Other	Time spent in class:	0.0	0.4
		Time spent in college outside class (e.g. in the library):	0.1	0.4
		The time you spend outside college (e.g. at home)	0.0	0.7
Non-computer based activities	Direct input from teacher	Time spent in class:	2.5	0.9
	Doing group or individual activities	Time spent in class:	0.7	0.7
		Time spent in college outside class (e.g. in the library):	0.4	0.4
		The time you spend outside college (e.g. at home)	0.5	0.7
	Using books, periodicals or other paper-based learning materials	Time spent in class:	1.1	0.8
		Time spent in college outside class (e.g. in the library):	0.6	0.6
		The time you spend outside college (e.g. at home)	0.9	0.9
	Other activity	Time spent in class:	0.0	0.1
		Time spent in college outside class (e.g. in the library):	0.0	0.1
		The time you spend outside college (e.g. at home)	0.0	0.1

NOTES:

1) Because there is a wide difference between the sum of all reported activities and the total figure data, I used the following formula to come to a proportional estimate of the time taken in different activities:

$$\frac{\text{Time reported for individual activity}}{\text{Sum of the time reported for all individual activities}} \times \text{Time reported as total time spent in various learning activities (data directly obtained in a separate question)}$$

A large proportion of records in the student-subject data set show a zero value for these categories. This accounts for the low mean times identified in Table 5-9 above. The time spent in class receiving direct input from the teacher appears to have dramatically reduced from 2.5 hours to 0.9 hours between 1998 and 2006. It has already been noted, however, that there may be some issues surrounding the accuracy of the reporting of time by students. An aggregation into the following types of activity was carried out, in order to eliminate the distorting effect of the large number of zero values:



The three analyses - i.e. ANOVA, correlation grid, multiple regression analysis - were repeated with the corresponding IT and non-IT based activity e.g. in college in class, in college outside class or outside college.

5.3.1.5 IT based activities

The results for IT activities replicate the same general picture in the sub-categories as in the aggregated category. These figures are displayed in Table 5-10.

Table 5-10: Breakdown of IT based activity categories

Independent variable		ANOVA		IT use quartile		Mean VAS	Mean difference: IT use quartile 1 Low	2 ←	3 →	4 High	Correlations: Pearson	Spearman	MRA: Coefficients	Significance
Sum all IT activities	**1998**	Significance	0.00	1	Low	-1.6		0.5	-1.2	-5.2	-0.3	-0.3	---	---
		Between groups	937.07	2	↑	-1.7	-0.5		-1.3	-5.3	-0.1	-0.1	1.9	0.4
		Total	3803.7	3	↓	-0.4	1.2	1.3		-4.0	-0.1	0.0	2.5	0.1
		Effect (Eta)	0.25	4	High	3.6	5.2	5.3	4.0		0.5	0.4	6.2	0.0
	2006	Significance	0.09	1	Low	6.2		0.1	2.0	0.9	0.1	0.1	---	---
		Between groups	210.40	2	↑	6.1	-0.1		2.0	0.9	0.0	0.0	1.4	0.6
		Total	21351.3	3	↓	4.3	-2.0	-1.9		-1.0	-0.1	-0.1	-1.6	0.5
		Effect (Eta)	0.01	4	High	5.3	-0.9	-0.8	1.0		0.0	0.0	-0.8	0.8
Sum IT in Class	**1998**	Significance	0.00	1	Low	---		---	---	---	---	---	---	---
		Between groups	807.82	2	↑	-1.2	---		-0.2	-4.6	-0.4	-0.3	---	---
		Total	3803.70	3	↓	-1.0	---	0.2		-4.4	-0.1	-0.1	1.0	0.6
		Effect (Eta)	0.21	4	High	3.3	---	4.6	4.4		0.5	0.4	3.8	0.1
	2006	Significance	0.86	1	Low	6.0		---	2.9	-0.9	0.1	0.1	---	---
		Between groups	603.35	2	↑	6.0	---		2.9	-0.9	0.1	0.1	---	---
		Total	21351.3	3	↓	3.0	-2.9	-2.9		-3.8	**-0.2**	**-0.2**	0.0	1.0
		Effect (Eta)	0.03	4	High	6.8	0.9	0.9	3.8		0.1	0.1	4.2	0.1
Sum IT in College outside class	**1998**	Significance	0.00	1	Low	---		---	---	---	---	---	---	---
		Between groups	703.01	2	↑	-1.1	---		-0.4	-4.5	-0.3	-0.3	---	---
		Total	3803.7	3	↓	-0.7	---	..43		-4.1	-0.1	-0.1	2.4	0.1
		Effect (Eta)	0.18	4	High	3.4	---	4.5	4.1		0.4	0.4	0.9	0.6
	2006	Significance	0.00	1	Low	5.3		-1.3	-0.6	-0.1	0.0	0.0	---	---
		Between groups	703.01	2	↑	6.6	1.3		0.7	1.2	0.0	0.0	4.0	0.1
		Total	3803.7	3	↓	5.9	0.6	-0.7		0.5	0.0	0.0	3.5	0.1
		Effect (Eta)	0.18	4	High	5.4	0.1	-1.2	-0.5		0.0	0.0	4.6	0.1
Sum IT outside college	**1998**	Significance	0.00	1	Low	---		---	---	---	---	---	---	---
		Between groups	47.44	2	↑	-1.4	---		-1.1	-4.9	-0.4	-0.3	---	---
		Total	21351.3	3	↓	-0.4	---	1.1		-3.8	-0.1	-0.1	1.7	0.2
		Effect (Eta)	0.00	4	High	3.5	---	4.9	3.8		0.5	0.4	5.5	0.0
	2006	Significance	0.61	1	Low	6.4		1.0	1.1	2.5	0.1	0.1	---	---
		Between groups	47.44	2	↑	5.4	-1.0		0.1	1.5	0.0	0.0	2.2	0.4
		Total	21351.3	3	↓	5.4	-1.1	-0.1		1.4	0.0	0.0	1.2	0.5
		Effect (Eta)	0.00	4	High	3.9	-2.5	-1.5	-1.4		-0.1	-0.1	0.8	0.7

NOTES:
1) Quartiles: 1 is the lower quartile and 4 is the upper quartile
2) Because of the range of data in certain quartiles, SPSS could not produce any means in certain categories (marked " ---")

The results for ANOVA, correlation and multiple regression analysis are discussed in turn.

5.3.1.5.1 ANOVA

There is little variation between the three IT based activity locations (i.e. in class, in college outside class and outside college).

The means for the 1998 quartiles (labelled in the table as Mean VAS) are roughly similar for each of the three activity locations and the sum of all IT based activities. It is worth noting that the difference between the lowest (i.e. the second quartile of values, the first quartile having been removed by SPSS) and highest (i.e. the upper quartile of values) mean value added scores are greatest in IT based activities outside college (4.9 residual UCAS points - i.e. a range of - 1.5 to 3.5). This is the activity which is furthest removed from the influence of the college. The difference is lowest (4.6 residual UCAS points - i.e. a range of -1.2 to 3.3) for IT based activities in class. This suggests the possibility that IT based activities which have least input from teachers, have the strongest relationship with value added performance; that is to say, where students overall have shown that their performance appeared to be enhanced by the use of IT, that performance was enhanced to a greater degree by use of IT outside college. The use of IT, even in a group setting, is still essentially a solitary activity, which relies on the individual interaction of the learner with the computer. However the evidence set out here needs corroboration before this relationship can be shown. The 2006 data does not support this. The greatest difference (3.8 residual UCAS points) between a highest value (6.8) and a lowest value (3.0) occurs between quartile 3 (lowest) and quartile 4 (highest) for IT activities in class, and the lowest difference (1.2 residual UCS points) is between the bottom two quartiles for IT activities in college outside class. The 2006 data shows a much less clear picture in which it is difficult to show that the hypothesis is confirmed or denied. The issue of whether the relationship between IT resources and performance is stronger with regard to activities which take place outside college will need further consideration.

There was more variation in means for the subcategories representing the different locations in 2006. The picture has been slightly distorted here by the fact that the breakdown of IT activities into activities in the different location categories has left some quartiles with small numbers.

Part of this distortion in the quartiles is due to the small amount of time reported. This caused some distortion in 1998, with quartile 1 being rejected by SPSS from the analysis; however, the distortion was greater in 2006.

In 1998, for each of these categories, the difference between the lowest and highest mean value added scores is lower than for the sum of all IT activities. In 2006 the lowest-highest difference was lower for the sum of all IT activities than for either IT activities outside college or IT activities in college outside class. The difference for the sum of all IT activities was greater than the difference for IT activities in class.

Although there is little variation, in 1998, IT activities outside college show the greatest effect size (shown by the Eta-squared). The effect size was negligible in all cases in 2006.

5.3.1.5.2 Correlations

The same pattern reveals itself in the Spearman correlation figures. In 1998 the figures in the breakdown do not vary substantially from the aggregated figures. The statistically significant positive correlation between those who spend most time in IT based activities (the upper quartile) and value added score grows slightly stronger the further students are from the direct input of teachers (a range from correlations of 0.35 to 0.44). In 2006 all correlations, both Spearman and Pearson, were very weak, effectively showing no correlation between the variables. A discussion of the minor variations between these correlations in the breakdown is not profitable here.

5.3.1.5.3 Multiple regression analysis

In 1998, the coefficients from the multiple regression analysis show a more mixed picture in which the relationship between IT activities outside college and value added score appear to be stronger and weaker for IT based activities in class. In 2006, none of the coefficients were statistically significant. Notwithstanding this, the variations in the relationship of IT activity to performance shown by the coefficients were marked. Quartile 1 was removed by SPSS from each of the regression analyses run. Quartile 2 ranged from being highest with regard to all IT activities (1.4) to the lowest for IT activities outside college (1.2). Quartile 3 ranged from -1.6 for all IT activities to 3.5 for IT activities in college outside class, and quartile 4 ranged from -0.8 for all IT activities to 4.6 for IT activities in college outside class.

5.3.1.6 Non-IT based activities

The results for non-IT activities are displayed in the table below. These repeat the same general picture in the sub-categories as in the aggregated category, that is, in 1998 the more time was spent on an activity the greater the performance, but the reverse appeared true in 2006.

Table 5-11: Breakdown of non-IT based activity categories

Independent variable		ANOVA									Correlations		MRA	
				Non-IT use quartile		Mean VAS	Mean difference: non-IT use quartile 1 (Low)	2 ←	3 →	4 (High)	Pearson	Spearman	Coefficients	Significance
Sum all non-IT activities	1998	Significance	0.00	1	Low	-0.3		0.6	0.4	-2.8	-0.1	-0.1	---	---
		Between groups	357.87	2	↑	-0.9	-0.6		-0.2	-3.4	-0.1	0.0	-2.0	0.2
		Total	3803.7	3	↓	-0.7	-0.4	0.2		-3.2	-0.1	-0.1	-1.4	0.4
		Effect (Eta)	0.09	4	High	2.5	2.8	3.4	3.2		0.3	0.2	1.1	0.6
	2006	Significance	0.25	1	Low	6.4		0.8	1.0	1.9	0.1	0.1	---	---
		Between groups	174.87	2	↑	5.6	-0.8		0.2	1.1	0.0	0.0	-2.0	0.4
		Total	21351.3	3	↓	5.4	-1.0	-0.2		0.9	0.0	0.0	-0.4	0.9
		Effect (Eta)	0.01	4	High	4.5	-1.9	-1.1	-0.9		-0.1	-0.1	-2.6	0.3
Sum non-IT in Class	1998	Significance	0.00	1	Low	-0.1		0.8	0.8	-2.7	0.0	0.0	1.2	0.4
		Between groups	3.69	2	↑	-0.9	-0.8		-0.1	-3.4	-0.1	-0.1	---	---
		Total	3803.7	3	↓	-0.9	-0.8	0.1		-3.4	-0.1	-0.1	1.4	0.4
		Effect (Eta)	0.00	4	High	2.2	2.7	3.4	3.4		0.3	0.2	2.2	0.4
	2006	Significance	0.81	1	Low	6.0		3.2	3.2	0.1	0.1	0.1	---	---
		Between groups	415.82	2	↑	6.0	-3.2		3.2	0.1	0.1	0.1	---	---
		Total	21351.3	3	↓	2.8	-3.2	-3.2		-3.0	**-0.1**	**-0.1**	-3.2	0.1
		Effect (Eta)	0.02	4	High	5.9	-0.1	-0.1	3.0		0.0	0.0	-3.4	0.2
Sum non-IT in College outside class	1998	Significance	0.01	1	Low	-0.7		1.3	-1.7	2.3	-0.1	-0.1	---	---
		Between groups	308.91	2	↑	-2.0	-1.3		-2.9	-3.6	-0.2	-0.2	-1.1	0.5
		Total	3803.7	3	↓	0.9	1.7	2.9		-0.6	0.1	0.1	1.5	0.5
		Effect (Eta)	0.08	4	High	1.6	2.3	3.6	0.6		0.2	0.2	1.4	0.5
	2006	Significance	0.01	1	Low	5.8		0.1	0.1	0.9	0.0	0.1	---	---
		Between groups	47.29	2	↑	5.8	-0.1		0.1	0.9	0.0	0.1	---	---
		Total	21351.3	3	↓	5.7	-0.1	-0.1		0.8	0.0	0.0	-3.1	0.1
		Effect (Eta)	0.00	4	High	4.9	-0.9	-0.9	-0.8		-0.1	-0.1	-5.5	0.0
Sum non-IT outside college	1998	Significance	0.02	1	Low	0.7		2.3	0.6	-0.3	0.1	0.1	2.2	0.2
		Between groups	184.96	2	↑	-1.6	-2.3		-1.8	-2.6	-0.2	-0.2	---	---
		Total	3803.7	3	↓	0.1	-0.6	1.8		-0.9	0.0	0.1	0.7	0.6
		Effect (Eta)	0.05	4	High	1.0	0.3	2.6	0.9		0.1	0.0	0.9	0.6
	2006	Significance	0.20	1	Low	6.6		3.9	0.7	**3.1**	**0.1**	0.1	---	---
		Between groups	664.25	2	↑	2.7	-3.9		-3.2	-0.9	-0.1	-0.1	-4.8	0.1
		Total	21351.3	3	↓	5.9	-0.7	3.2		2.3	0.0	0.0	-2.0	0.3
		Effect (Eta)	0.03	4	High	3.5	**-3.1**	0.9	-2.3		**-0.1**	**-0.1**	-4.8	0.0

NOTES:
1) Quartiles: 1 is the lower quartile and 4 is the upper quartile
2) Because of the range of data in certain quartiles, SPSS could not produce any means in certain categories (marked " ---")

5.3.1.6.1 ANOVA

The pattern observed for IT based activities in 1998 was that the relationship between time spent and performance was stronger for activities taking place further from the control of teachers. That is good scores got better and bad scores worse. This pattern was reversed for non-IT based activities, although the importance of this reversal is negated by the effect size which is at 0 for non-IT based activities in class. The greatest difference between the highest and lowest mean value added score for non-IT based activities in any location is for activities in class (a range of 2.4 residual UCAS points). The smallest difference is activities outside college (a range of 0.3 points). The aggregated non-IT based activities had a range of 2.3 points.

For 2006, the pattern for non-IT activities was similar to that for IT based activities - the greatest difference (3.9 residual UCAS points) between a highest value (6.6) and a lowest value (2.7) occurs for the bottom two quartiles of time spent in non-IT activities outside college. In general, the lowest quartiles showed a higher value added score than for the higher quartiles, although the order in which this is occurred varied between the different activity locations. There is no clear pattern here.

5.3.1.6.2 Correlations

In 1998, unlike IT based activities, the correlations between time spent in non-IT based activities and value added score grew weaker the more the influence of the teacher was removed (ranging from a correlation of 0.19 down to 0.04). All of these correlations are weak, and so caution needs to be taken in placing too much emphasis on this.

In 2006, as with all of the correlations for IT based activities, those for non-IT based activities were very weak. The range of both sets of correlations ran from a lowest of – 0.10 to a highest of 0.09. Within this narrow range there was variation between the different location categories, but the range is so narrow that discussion of them does not elucidate the matter.

5.3.1.6.3 Multiple regression analysis

In the 1998 multiple regression analysis none of the non-IT based activity categories were statistically significant. Apart from this, a similar picture emerges as with the correlation grid above: the closer the student is to the influence of the teacher, the stronger the interrelationship between that activity and performance (coefficients for those who spend most time in non-IT based activities - in class: 2.2; in college outside class 1.4 outside college 0.9). In 2006, only quartile 4 of time spent in non-IT activities in class was statistically significant. This coefficient (-2.5) suggested that the more time a student spent in class engaged in non-IT based activities, the less likely they were to achieve a higher value added score. This might seem to be positive evidence towards confirming the hypothesis that time spent on IT based activities was more effective than time spent in non-IT based activities, however, this should be viewed with caution as the rest of the results for the 2006 data set do not suggest that there is any clear relationship at all.

5.3.1.7 Summary

Looking at the 1998 data alone, it would appear that the hypothesis in question 1 that there is a stronger interrelationship between engagement in IT based activities and the performance of students than non-IT based activities has been substantiated. The best performing students were also the students who engaged most in activities which utilised IT based resources. However the picture which emerges from the 2006 data set contradicts this. This means that the hypothesis for question one, based on the results as a whole, has not been proved. The contradictory message from the two sets of results suggests a number of possibilities. The methodology may have omitted to account for certain factors which influence the results, or the differing results may indicate a level of randomness. The reliability of the reporting by students on how much time they spend on different activities may have a bearing here. One possibility to explore further is the effect of the eight year gap between the data collections in which technology changed and perhaps, more importantly, became far more widespread and integrated into everyday life. Another possibility is suggested by the fact that the mean value added scores for the 2006 collection were all higher than the mean value added score for the upper quartile in 1998. It may be that the effects of IT are most pronounced in initially boosting value added score, but that when other factors have already boosted the value added score the returns from reliance on IT based activities are diminished. These will be discussed in the conclusions to the study; however they need to be borne in mind in consideration of the remaining questions.

5.3.2 Consideration of question 2

Can the interrelationship between engagement in IT based activities and performance be distinguished from the general hard work factor demonstrated by greater engagement in all activities?

5.3.2.1 Analysis of the question

Although it appears that there is a positive interrelationship between time spent in IT based activities and performance, as suggested by the 1998 data, it is possible that any associated improvement in performance may be related to a "hard work" factor rather than any greater effectiveness of using IT resources in learning activities. This "hard work" factor might explain the increase in value added scores amongst those who spent more time engaged in IT based activities. It may be that they were spending more time engaged in all activities and that better performance can be related to the "*time spent*" rather than the *"IT"* part of "*time spent in IT based activities"*.

Time spent therefore needs to be separated from the IT aspect of the activities.

5.3.2.2 Mapping time spent in activities against performance

If those who spend the greatest proportion of their time in IT based activities, were also those in the highest performing group, then it is possible that it is the effectiveness of the use of IT in the activity rather than the time spent which is leading to the performance gains. To investigate the relationship here, time spent in the different IT and non-IT activities was mapped against performance. Further research, beyond the scope of this study, may be required to distinguish any differences revealed from those attributable to other personal characteristics such as learning style.

The data variables on time spent in different activities were categorised by the performance quartile they fell into. The mean time taken over each of the activity categories was then ascertained for each quartile. The proportion of time spent on average by each quartile on each activity could then be ascertained and ranked.

Table 5-12: Proportion of time spent in different activities - ranked for each quartile

Quartile of value added score	1998	2006
1	1. Non-IT In class (55%) 2. Non-IT outside college (19%) 3. Non-IT in college outside class (9%) 4. IT In college outside class (7%) 5. IT outside college (6%) 6. IT in Class (3%)	1. IT In class (29%) 2. IT In college outside class (22%) 3. IT outside college (18%) 4. Non-IT In class (13%) 5. Non-IT in college outside class (10%) 6. Non-IT outside college (8%)
2	1. Non-IT In class (51%) 2. Non-IT outside college (21%) 3. Non-IT in college outside class (12%) 4. IT In class (6%) 5. IT In college outside class (5%) 6. IT outside college (5%)	1. IT In class (25%) 2. IT outside college (19%) 3. Non-IT In class (19%) 4. Non-IT outside college (13%) 5. Non-IT in college outside class (12%) 6. IT In college outside class (11%)
3	1. Non-IT In class (54%) 2. Non-IT outside college (15%) 3. IT In college outside class (11%) 4. IT In class (9%) 5. Non-IT in college outside class (7%) 6. IT outside college (4%)	1. IT outside college (24%) 2. IT In class (22%) 3. Non-IT In class (19%) 4. Non-IT in college outside class (13%) 5. IT In college outside class (12%) 6. Non-IT outside college (10%)
4	1. Non-IT In class (36%) 2. IT In college outside class (18%) 3. IT In class (15%) 4. IT outside college (11%) 5. Non-IT in college outside class (11%) 6. Non-IT outside college (10%)	1. Non-IT In class (23%) 2. IT In class (22%) 3. IT outside college (21%) 4. Non-IT outside college (12%) 5. Non-IT in college outside class (11%) 6. IT In college outside class (11%)

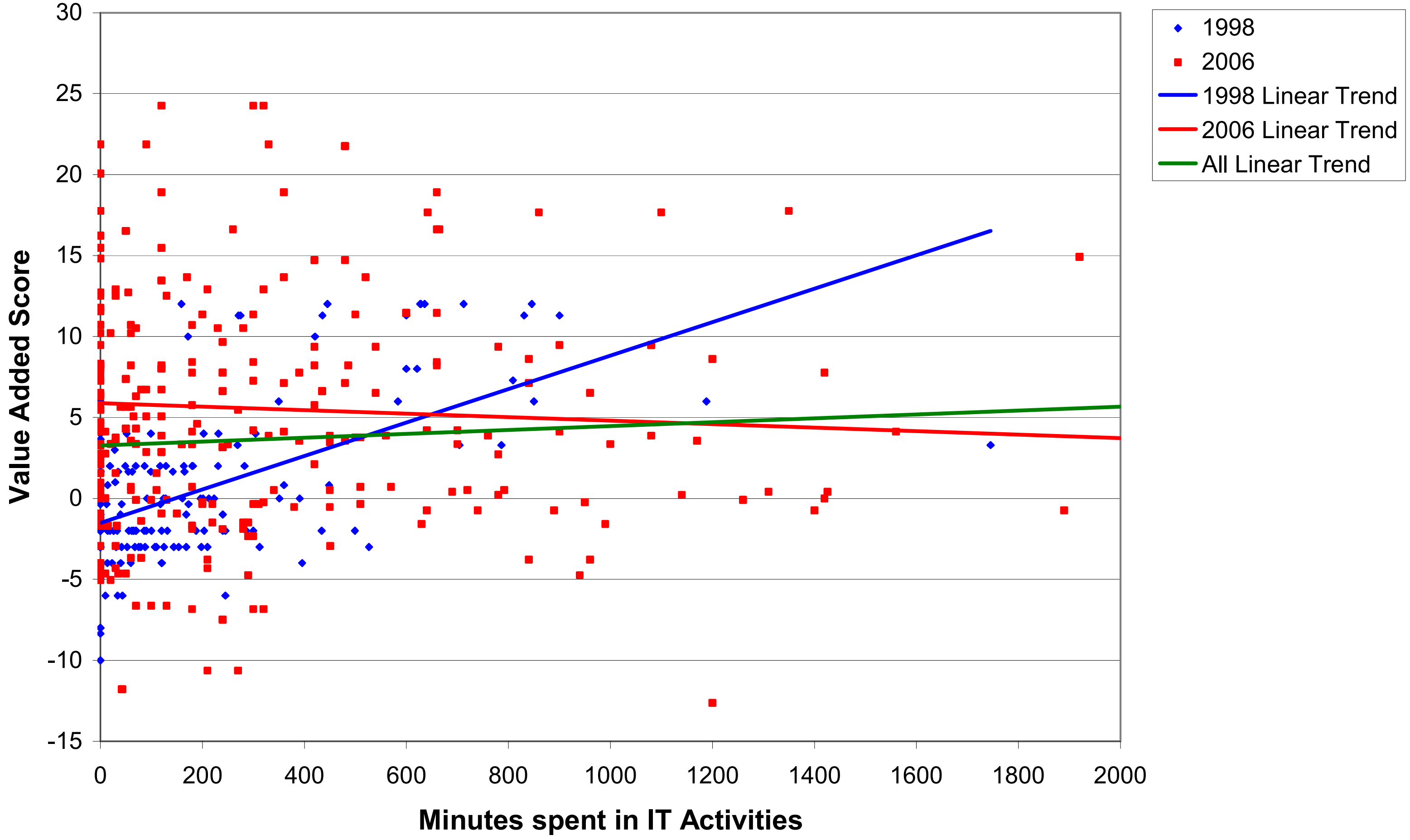
In 1998 the pattern was fairly clear. The students in the two lower quartiles spent more time in non-IT based activities (an aggregate of 83% non-IT for quartile 1 and 84% for quartile 2), when compared to the upper two quartiles (quartile 3: 76% non-IT, quartile 4: 56% non-IT). Also of interest is that, apart from activities in class, the upper quartile spent more time in IT activities than in the respective non-IT alternatives.

In 2006 the opposite was true. The students in all quartiles spent more time in IT based activities; however, those in the lower quartiles spent a greater proportion of their time in

IT based activities (aggregated to 69% for quartile 1, 55% for quartile 2, 58% for quartile 3 and 54% for quartile 4).

A scatter graph comparing the relationship between value added score and the time spent in IT activities illustrates the opposing trends from 1998 and 2006. This is shown in Figure 5-3.

Figure 5-3



Value added score - time spent in IT activities regression

This scatter graph appears to indicate that for 1998 students (indicated in blue), the more time spent in IT based activities, the greater their likelihood of achieving a higher value added score. The gradient on the trend line for the 2006 students was flat indicating that there was no relationship between time spent in IT activities and value added score. It should be noted, however, that the rise in the gradient of the trend line for the 1998 students is driven by a small group of students with high value added scores who spent a long time in IT activities. It is important to establish whether these students can be defined as outliers. In a normal distribution curve 99.7% of values should lie within three standard deviations of the mean. Taking this standard definition of an outlier, none of the 244 students-subjects logged for 1998 were outliers for value added score and two were outliers for time spent in IT activities. Removing these two student-subjects did not greatly affect the gradient of the line. 95% of students in a normal distribution curve lie within two standard deviations of the mean. Taking this as the definition of an outlier, there are 15 student-subjects who are outliers for value added score (10 points or more). There are 15 student-subjects who are outliers for time spent IT based activities (greater than 620 minutes). Seven student-subjects come within both categories. There are 23 student-subjects which fit into either category. Looking at the descriptive statistics for this "outlier" group of student-subjects does little to distinguish them from the sample as a whole. None of the 23 records represented several subjects studied by one student, and so the 23 records also represent the variables for 23 students. These 23 students are evenly split by gender (12 Female, 11, male), and this split is repeated when only the outliers for value added score are considered, and when only the outliers for time spent in IT activities is considered. The ethnicity breakdown of these students reflected the ethnic makeup of the course as a whole, with the majority (22) being of a South Asian ethnic classification. 17 of the group had access to a computer at home (73%) which is broadly in line with the sample as a whole (64%) when the small size of the "outlier" group is taken in to consideration. It is only under course category where there appears to be a distinction between the sub-group and the sample as a whole. 17 records are for subjects in faculty category 2 (Business studies) with the remaining students spread evenly amongst the other faculty categories. It may be that the positive association between IT activities and value added score may be related to some attribute of this faculty. The issues surrounding the relationship between the faculty in which a subject is studied and value added score will be discussed further under question 3 below.

Notwithstanding the issues set out above, this scatter graph suggests the possibility that where the lines cross, at just over 10 hours (600 minutes) spent per week in IT based activities may represent an optimum time. This is confirmed by scatter graphs showing those who spend less than 600 minutes and those who spend more than 600 minutes. This is shown in Figures 5-4 and 5-5 overleaf.

Figure 5-4: Value added score - time spent in IT activities regression (under 600 minutes)

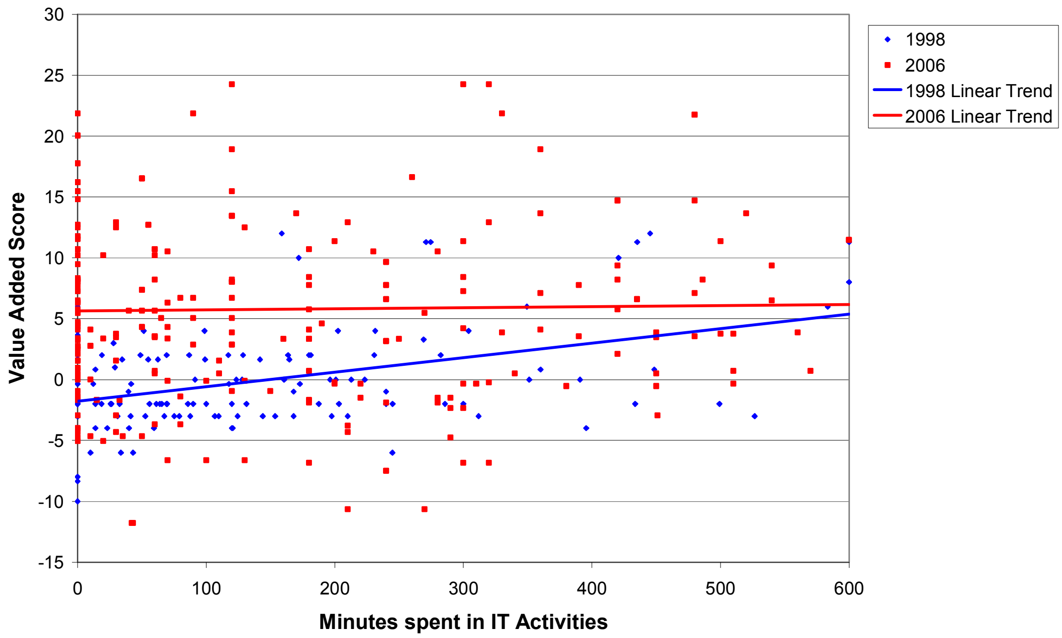
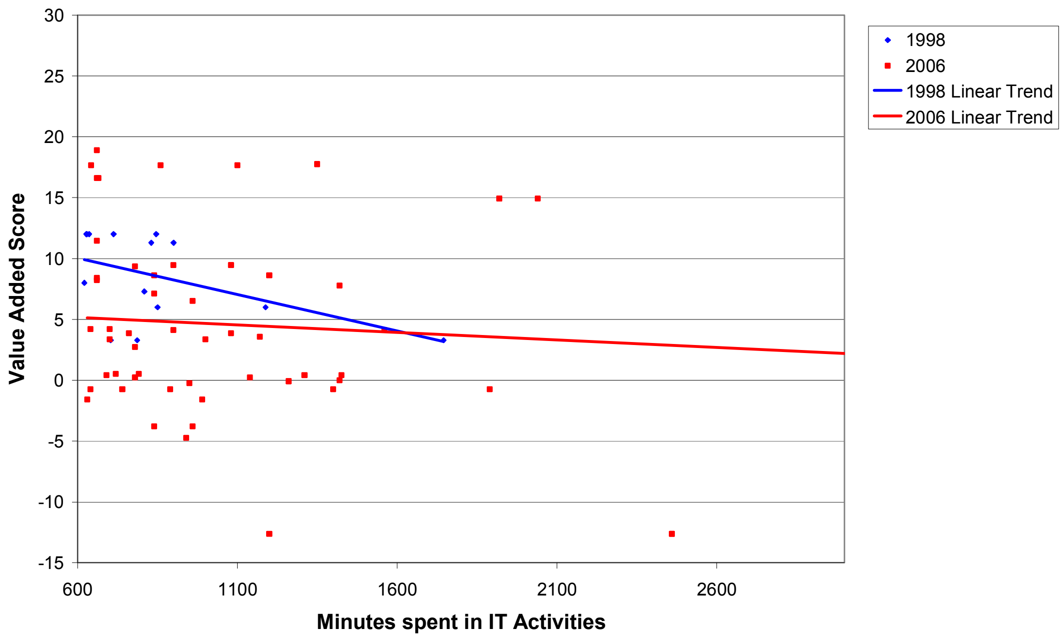


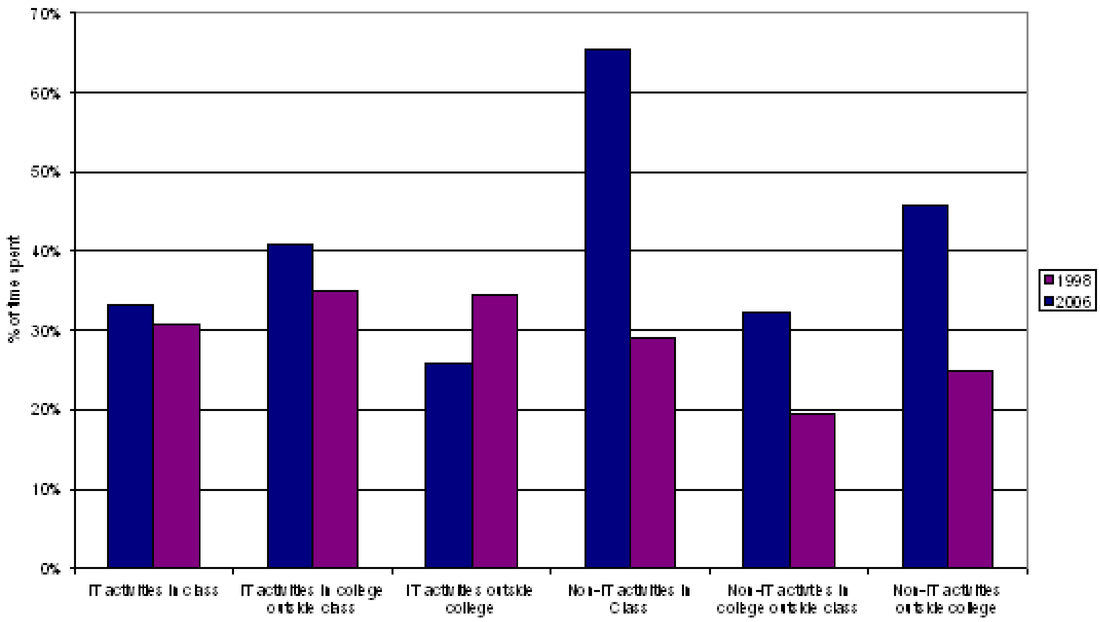
Figure 5-5: Value added score - time spent in IT activities regression (over 600 minutes)



Taken together, these two scatter graphs show that performance increases for students who spend fewer than 600 minutes in IT activities (markedly so for 1998, much less so for 2006), but that students who spend more than 600 minutes in IT based activities performed worse. The apparent contradiction with the trend shown in question 1 can be explained by so few students in 1998 spending more than 600 minutes using IT resources. A similar analysis can be conducted for non-IT activities showing that an optimum occurs at around 15 hours (900 minutes).

In 1998, for all the quartiles, carrying out non-IT based activities in class takes up the greatest proportion of time. This is because the time spent in class is predetermined - providing students attend as they should. In 2006, however, this was only true for quartile 4. In 2006 students in quartiles 1 and 2 reported that they spent most time in IT activities in class, with quartile 3 reporting more time in IT activities outside college. The proportions of time spent in different activities can be seen illustrated in the Figure 5-6.

Figure 5-6: Proportions of time spent in different activities



5.3.2.3 The “hard work” factor

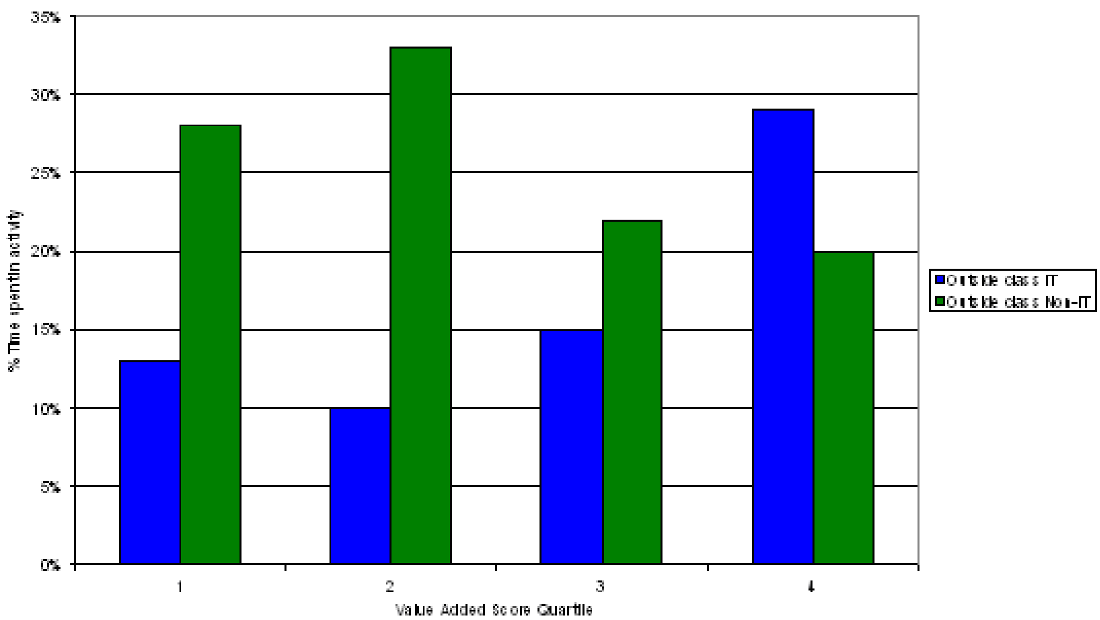
The time spent outside class, where a student is self-directed and self-motivated may be a better indicator of a “hard work” factor. The mean percentage of time spent outside class is set out in Table 5-13:

Table 5-13: Time spent outside class

		Mean % time spent for each value added score quartile			
		1	2	3	4
1998	Outside class IT	13%	10%	15%	29%
	Outside class non-IT	28%	33%	22%	20%
	Total outside class	41%	43%	37%	50%
2006	Outside class IT	29%	25%	22%	22%
	Outside class non-IT	22%	11%	12%	11%
	Total outside class	51%	36%	34%	33%

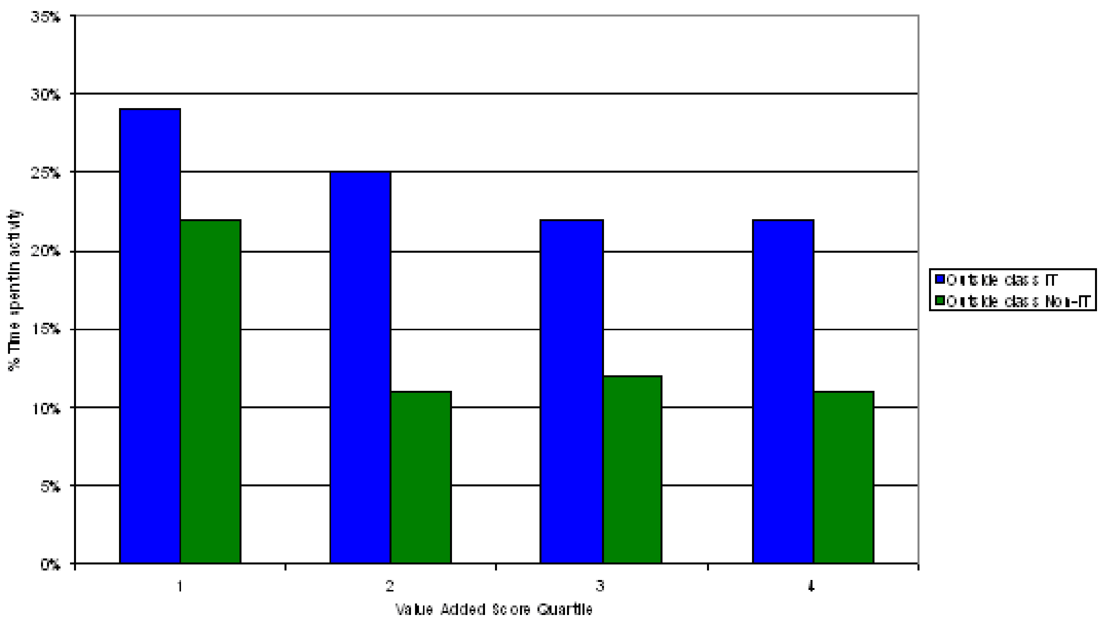
Looking at the time spent out of class for 1998, we can see it is only in the upper quartile that the time spent on IT activities outside class is greater than the time spent in non-IT activities.

Figure 5-7: Percentage of time spent outside class in IT and non-IT activities (1998)



In 2006, for all quartiles, more time out of class was spent in IT than in non-IT based activities, although there was less difference between the quartiles.

Figure 5-8: Percentage of time spent outside class in IT and non-IT activities (2006)



This corroborates the intriguing pattern which is beginning to emerge from this consideration of the data. In 1998 only the upper quartile produced a mean value added score which was positive, whereas all quartiles had a positive value added score in 2006. The lowest mean value added score for the 2006 quartiles was greater than the highest mean value added score in 1998. At the same time we see that only the upper quartile spent more time in IT based activities in 1998, but all quartiles did so in 2006. In the previous section there was a suggestion that there was an optimum time spent in IT based activities in order to increase value added score. The figures here suggest that there is an optimum proportion of time to spend in IT activities outside college. In 1998, the quartiles with negative value added score averaged in the range of 10 – 15% of their time in IT based activities outside class. Only the upper quartile spent longer (mean 29%), and gained positive value added scores. In 2006 all quartiles spent between a mean of 22%

and 29% of their time in IT based activities outside college, and all gained a positive value added score.

In order to distinguish further hard work from the IT aspect it is worth looking at the actual mean times spent in each activity to see if those who performed better spent more time in total than the other students.

Table 5-14: Mean time taken in each activity by the four performance quartiles.

		Mean time in hours					
		IT			Non-IT		
Data	Value added score quartile	In class	In college outside class	Outside college	In class	in college outside class	Outside college
1998	1	0.21	0.42	0.38	3.39	0.56	1.15
	2	0.37	0.31	0.28	3.00	0.71	1.21
	3	0.57	0.65	0.27	3.31	0.42	0.89
	4	2.36	2.96	1.82	5.80	1.72	1.58
2006	1	1.43	1.91	3.21	0.89	1.11	2.35
	2	1.39	1.44	0.19	1.00	0.92	0.84
	3	1.59	1.98	1.79	0.84	1.03	0.96
	4	1.65	1.56	1.64	0.86	0.80	0.79

What is immediately noticeable from Table 5-14, showing as it does actual times rather than proportions of time, is that in 1998, those who perform best (quartile 4) spend much longer in each activity type than the other students. That is to say, those students who perform better appear to work “harder”. In 2006, hard work appeared to be associated with lower value added scores. Here the accuracy issues, already discussed, concerning the reporting of time by students, need to be borne in mind. The students in 2006, in general, reported more time spent in all activities. For 2006, it is hard to discern whether the “hard work” factor can be distinguished from the effects of the use of IT resources.

5.3.2.4 Summary

This question attempts to distinguish the possible improvements in effectiveness of IT activity from general improvements in performance attributable to hard work as measured by spending more time in study. Taken on their own, the figures for 1998 and 2006 appear to give contradictory results. In 1998, only students in the upper performance quartile achieved a positive value added score, and these students were shown not only to spend more time in IT based activities, measured in absolute terms, but also a greater proportion of their time. This suggests that for these students there was a positive relationship between their use of IT resources and their value added performance, although this may also be related to the subject studied. In 2006, the opposite appeared to be true. The picture which was shown by the 2006 data was less clear, as those in the lower quartiles spent a greater proportion of their time in the IT based activities. The 2006 figures, taken alone, suggest that there was a clearer relationship between the “hard work” factor and performance than for the use of IT resources.

Taking the figures for 1998 and 2006 together gives a different picture. However this should be done with caution, as other factors differentiating between the years mean that like is not being compared with like. These factors may include the ubiquity of IT resources and other changes in the management of the college since 1998. These will be discussed in the next chapter. If the two data sets are taken together, the mean value added score for the lower quartile in 2006 was greater than the score for the upper quartile in 1998, and so comparing each quartile presents a distorting picture. However, taken together the two data sets suggest that increasing the use of IT resources in learning activities may boost performance up to a point – the figures I have suggest that this might be around 10 hours per week – and after that the contribution to performance of activities using IT resources diminishes. Further gains in performance then rely on the "hard work" or other factors..

5.3.3 Consideration of question 3

Is the relationship between participation in IT activities and performance affected by choice of subject?

The hypothesis to be tested here was that higher performance by students is related to their choice of subject .

Consideration of this question requires the relationship between the subject studied and performance to be isolated from that of the use of resources. If this were shown to be the case, further questions would be raised as to what it is about that subject which makes the difference to performance, such as certain characteristics that it better suits the use of IT resources.

The analysis below shows that relationship between choice of subject and performance does not appear to be strong.

5.3.3.1 ANOVA of performance in different faculty categories

A good place to start is an analysis of variance between the faculties. This analysis was set up with the value added score as the dependent variable and the faculty category as the independent variable. There are therefore 10 faculty categories between which to find variance.

5.3.3.1.1 Descriptive data

The ANOVA descriptive data shows the relationship between faculty and value added scores by comparing the mean value added score (VAS). Table 5-15, below, shows the pattern which emerges (units are in residual UCAS points).

Table 5-15: Faculty value added categorisation

	Mean	**Underperforming** Faculties with a VAS more than 1 point below the mean	**Near to mean** Faculties with a VAS broadly the same as the mean (less than 1 point difference)	**Over-performing** Faculties with a VAS more than 1 point greater than the mean
1998	**0.09**	**Less than -0.91**	**Ranging from -0.91 to 1.09**	**More than 1.09**
		• English (-0.6) • Maths (-2.2) • Science –(1.6)	• Art & design (0.4) • Humanities and social studies (-0.6) • Performance arts (0.4) • IT (0.7)	• Business studies (4.2) • Other languages (2.4) • General studies (1.3)
2006	**5.54**	**Less than 4.54**	**Ranging from 4.54 to 6.54**	**More than 6.54**
		• Art & design (3.5) • Maths (3.7) • Performance arts (4.5) • Science (3.4)	• Business studies (5.8) • IT (5.0)	• English (6.9) • Humanities and social Studies (7.4) • Other languages (9.6)
Faculties occurring in the same category in both years		• Maths • Science	• IT	• Other languages

The groupings in the table allow us to formulate a hypothesis about which faculties we expect to have a negative relationship with value added score (faculties with a VAS more than 1 point below the mean); those which we expect will have no strong relationship (faculties with a VAS broadly the same as the mean) and those we expect to have a positive relationship (faculties with a VAS more than 1 point above the mean).

There is some consistency between the years, with maths and science being in the under-performing category, “other languages” being in the over-performing category and IT in the middle category for both years. Between 1998 and 2006, art and design, business studies and performance arts have dropped down a category each, humanities and social studies has gone up one and English has gone up two categories from "under-performing" to "over-performing."

The 1998 FEFC inspection report on the college gave all study areas a grade 2 ("provision in which the strengths clearly outweigh the weaknesses" - FEFC,1999, p.2), except for art and design which was given a grade 3 ("provision with a balance of strengths and weaknesses" FEFC, 1999, p.2). The 2001 inspection report (OFSTED, 2001) gave all subject areas a grade 2 ("Good"), except for business and other languages which were graded as "outstanding" – the top grade. The 2006 OFSTED inspection report (OFSTED, 2006) did not give grades to subject areas but under the headings *effectiveness of provision*, *capacity to improve*, *achievements and standards*, and *Leadership and management*. Each of these received the top grade ("outstanding") apart from *Achievements and standards* which achieved a grade 2 ("good"). This grading is due to the *Achievements and standards* heading being linked to absolute performance, as well as value added performance.

5.3.3.1.2 The ANOVA table

Details of the table can be seen in Appendix 4e. In 1998 the analysis shows a significance figure of 0.00, suggesting a relationship. In 2006, the significance figure was 0.93, showing as not statistically significant.

In 1998, as well as being statistically significant, the indicated effect size based on the Eta-squared statistic was large at 0.25. In 2006, the effect size was much smaller at 0.06.

These differences are explored further in Table 5-16.

Table 5-16: 1998 Course categories - mean difference in VAS (Residual UCAS points)

Faculty category	2 Business studies	3 English	4 Humanities and social studies	5 IT	6 Maths	7 Other languages	8 Performance arts	9 Science	10 General studies
1 Art & design	3.8	-2.5	-1.0	0.3	-2.6	2.0	0.0	-2.0	0.9
2 Business studies		**-6.4***	**-4.8***	-3.5	**-6.4***	-1.8	-3.9	**-5.8***	-3.0
3 English			1.5	2.9	0.0	4.6	2.5	0.5	3.4
4 Humanities and social studies				1.3	-1.6	3.0	1.0	-1.0	1.9
5 IT					-2.9	1.7	-0.3	-2.3	0.6
6 Maths						4.6	2.6	0.6	3.4
7 Other languages							-2.1	-4.0	-1.2
8 Performance arts								-2.0	0.9
9 Science									2.9
10 General studies									
Those cells where the result was indicated as significant at the 0.05 level are marked in bold with an asterisk.									

The data in Table 5-16 confirms the picture built up by the descriptive statistics table. A difference was shown between business studies students and other subjects. The positive association between business studies and value added score was also noted in the context of the previous research question. There was a statistically significant difference between faculty category 2 (business studies), 3 (English), 4 (humanities and social studies), 6 (maths) and 9 (science).

Table 5-17: 2006 Course categories - mean difference in VAS (Residual UCAS points)

Faculty category	2 Business studies	3 English	4 Humanities and social studies	5 IT	6 Maths	7 Other languages	8 Performance arts	9 Science	10 General studies
1 Art & design	-2.3	-3.4	-3.9	-1.4	-0.1	-6.0	-0.9	0.1	
2 Business studies		-1.1	-1.6	0.9	2.1	-3.7	1.4	2.4	
3 English			-0.5	2.0	3.3	-2.6	2.5	3.6	
4 Humanities and social studies				2.5	3.7	-2.1	3.0	**4.0***	
5 IT					1.3	-4.6	0.5	1.6	
6 Maths						-5.9	-0.8	0.3	
7 Other languages							5.1	6.2	
8 Performance arts								1.1	
9 Science									
10 General studies									
Those cells where the result was indicated as significant at the 0.05 level are marked in bold with an asterisk.									

In 2006, a preliminary analysis of the ANOVA descriptives suggested that there was no clear relationship between faculty category and performance. This is corroborated by Table 5-17, which shows only one statistically significant difference.

5.3.3.2 Correlations

In 1998, although a statistically significant relationship was shown between value added score and faculty category 2 (business studies), 3 (English), 6 (maths) and 9 (science) it gave only a weak correlation:

Faculty	**Correlation**	**Significance**
Business studies	0.31	0.00
English	-0.22	0.00
Maths	-0.20	0.00
Science	-0.15	0.00

There was a positive correlation with value added score for business (faculty category 2) and a weak negative correlation between VAS and faculties 3, 6 and 9 and value added score. These negative correlations are probably too weak to be meaningful but suggest a picture consistent with that set out in the ANOVA results.

In 2006, again all the correlations were weak, more so than in 1998. There were three statistically significant correlations between faculty category and value added score.

Faculty	Correlation	Significance
Humanities and social studies	0.18	0.00
Maths	-0.11	0.04
Science	-0.19	0.00

The statistically significant correlation between courses studied in the science faculty and value added score (0.19) was also the strongest. This is of interest, because the value added score for science showed as underperforming in both 1998 and 2006.

5.3.3.3 Multiple regression analysis

The coefficients from the multiple regressions analysis are shown in Table 5-18.

Table 5-18: Ranking of coefficients in the multiple regression analysis - course categories

Variable	**Coefficient**	
	1998	**2006**
Age at Survey	**1.7**	**2.9**
Quartile of IT use 2	1.9	1.4
Quartile of IT use 3	2.5	-1.6
Quartile of IT use 4	**6.2**	0.8
Quartile of non-IT use 2	-2.0	-2.0
Quartile of non-IT use 3	-1.4	-0.4
Quartile of non-IT use 4	1.1	-2.6
Art & design	Excluded	0.2
Business studies	0.1	2.1
English	-3.2	**3.5**
Humanities and social studies	Excluded	**4.6**
IT	-1.8	2.3
Maths	-3.7	-1.0
Other languages	-3.6	**5.0**
Performance arts	-0.3	Excluded
Science	5.0	Excluded
IT input score	-0.2	**-9.1**
NOTES 1) Data taken from SPSS model 2 of the two stage analysis 2) Those variables marked "excluded" were excluded by the SPSS analysis 3) Those coefficients significant at the 0.05 level are marked in **bold**		

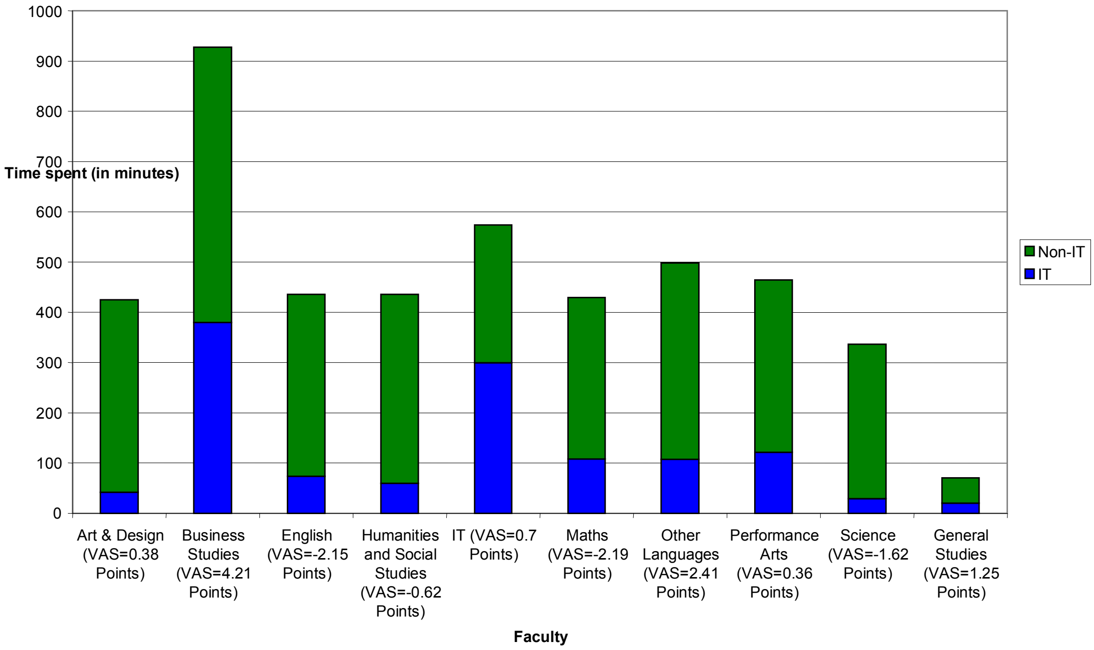
In the 1998 multiple regression analysis, while none of the faculty variables were statistically significant, all the faculty variables showed a negative relationship with value added score apart from general studies and business studies. General studies is a cross curricular category, and the strong relationship with value added score is not easy to explain from curriculum content or delivery methods. It may well be that general studies students are self-selecting, as general studies is often an extra A-level, taken beyond the three normally studied and may be selected by students who feel they will do well. The positive relationship between business studies and value added score is consistent with the picture built up above. The other faculties' negative relationship provides a less clear picture. In 2006, English (coefficient 3.5); humanities (coefficient 4.6) and other languages (coefficient 5.0) showed as having a relationship which was statistically significant. This relationship was positive and strong, ranking the highest three of all the variables in the study. This appears to show that for these subjects there is a relationship, which seems at variance with the picture suggested by the ANOVA data and the Spearman correlations.

5.3.3.4 Time spent by student in each faculty category

From the analyses above there is a suggestion that in specific cases, for instance business studies in 1998, there may be a relationship between the faculty in which a subject is taught and performance. Before reaching any firm conclusions about this, it is important to distinguish the "hard work" factor, discussed in relation to the previous section. It may be that students in faculties which appear to have a greater relationship with performance may in fact be spending more time in study, and it is this relationship which is being observed.

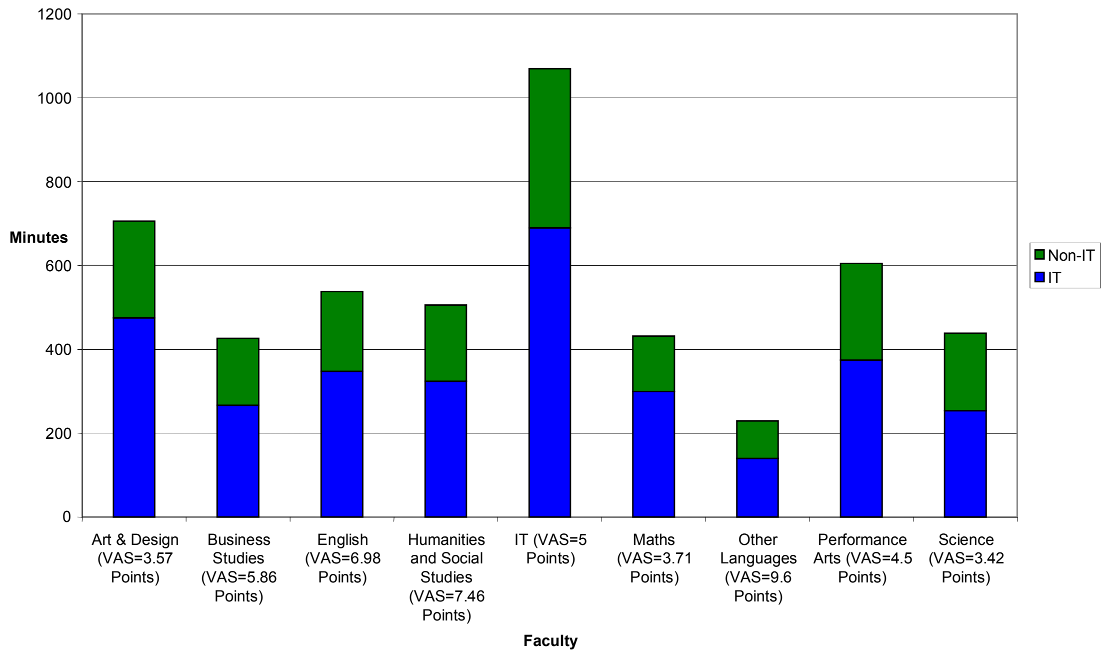
The charts below show the actual time spent by students in IT and non-IT activities by faculty.

Figure 5-9: Time spent by students in each faculty (1998)



In 1998, the only faculty category which appeared to show an relationship with increased performance was business studies. The chart above shows clearly that business studies students spent longer in both IT and non-IT based activities. The correlation between this faculty and performance was weak, and the increases in performance by business studies students can probably be attributed to the greater time spent studying. The picture from 2006 was less clear, as can be seen in Figure 5-10.

Figure 5-10: Time spent by students in each faculty (2006)



In 2006, all statistically significant correlations were very weak. The multiple regression analysis suggested that English, humanities and other languages might have a positive relationship with performance. In the figure 5-10, above, students in these faculties do not spend more time in study than other students, and so the apparent relationship cannot be set aside in the same way as that of business studies in 1998. In 2006, students studying ICT spent longer in both IT and non-IT activities, but the relationship with time spent was weaker, and not statistically significant.

5.3.3.5 Summary

From the analyses above it would appear that the faculty in which a course is studied may have a weak relationship with performance. In 1998, the analyses identified business studies courses as possibly having a positive relationship with value added score. When the regression was re-run without business students the rankings are mostly replicated, although the coefficients varied. However this apparent relationship can be set aside when the greater time spent by business studies students is taken into account. The 1998 FEFC inspection report identified that "Most teaching sessions in business studies were effective" (FEFC, 1998, p13) but noted that IT software was outdated. The business faculty was not singled out for any particular praise by the report. However, the 2001 inspection report) gave the business faculty one of only two top "outstanding" grades, commenting that "teaching was best in business studies and community languages." (OFSTED, 2001, p10) and

> Excellent teaching in business studies enables students to develop high standards of specialist knowledge, understanding and skills. Students clearly enjoy learning and make excellent progress relative to their prior achievement. There is strong leadership and a sense of purpose that is shared by staff and students, which leads to the fulfilment of individual potential and equality of opportunity
>
> (OFSTED, 2001, p. 5)

It may be that the improvements observed by inspectors in 2001 were already incipient when the 1998 data was being collected.

In 2006, the only apparent relationship with performance was that shown by English, humanities and other languages in the multiple regression analysis, and was not corroborated by the other analyses. In the 2001 inspection report, English and humanities provision were graded “good”, and other languages provision was graded “outstanding”. The 2006 inspection report identified English in a list of subjects where progress is “outstanding”, but does not include humanities or other languages in this list.

It should be noted that the method of calculating the value added score, deriving from DfES (1999) - see section 3.2.2.3.7 above - does not take any account of the differences in difficulty between subjects. The recent analysis of Coe *et al.* (2008), which concurred with the previous body of literature in the field, showed that there was consistency between the different methods used in establishing an index of difficulty (p84). Business studies ranged in relative difficulty from -0.41 to -.014: a negative figure indicating relative ease. The relative difficulty of English in Coe’s analysis ranged from -0.43 to -0.06, again indicating relative ease. This then may be another reason for the apparently higher performance figures for these subjects.

For clear indication that improvement in performance is related to participation in IT based activities it must be shown that this improvement takes place evenly across all subjects. The analyses above do not identify clearly any subject areas in which there was a strong relationship with high performance,, which can be distinguished from the learning activities, whether IT or non-IT based, which are provided by that faculty.

5.3.4 Consideration of question 4

Is the relationship between participation in IT activities and performance affected by previous experience of using IT resources?

The hypothesis tested here is that increases in performance related to the efficiency of IT resources are greater for students who have had access to IT resources prior to coming to college. It was shown that possession of such IT qualifications may have a weak negative relationship with performance. The hypothesis was investigated by the following three analyses.

1) The variance of those students who have an IT qualification prior to entry and those who do not.

2) The correlation between possession of an IT qualification prior to entry and value added score.

3) The coefficient in the multiple regression analysis.

5.3.4.1 Variance

There are only two categories here: those who have an IT qualification prior to entry and those who do not, and so a full ANOVA test is unnecessary. A yes/no variable was chosen here because the range of different IT qualifications held by students on entry made a more complex gradation of score difficult. In 1998 the mean value added score for those with an IT qualification score on entry was -0.5 UCAS residual points and for those without 0.3 UCAS points, i.e. those without an IT input score on average achieved a higher value added score. This picture was also true in 2006: those with an IT qualification on entry achieved a value added score of – 0.8, whereas those without an IT qualification on entry achieved a mean value added score of 5.9.

This seems to indicate that there is a relationship between possession of an IT qualification prior to entry and performance. It might have been expected that possession of an IT qualification on entry was associated with higher performance because the IT qualification might enable use without time spent on further instruction. In reality, in both 1998 and 2006 possession of an IT qualification was associated with lower performance . Here the possession of an IT qualification prior to commencing study is being taken as a proxy for prior experience. It is acknowledged that many students will have experience without this being certified with a qualification; however the opposite should not be true, all those with a qualification will have experience. It might be expected that a greater proportion of those students with an IT qualification would have the skills to make good use of IT resources in their study without further instruction. Caution should be taken with regard to these results because of the relative sample sizes. In 1998, 23% of the sample represented students who possessed an IT qualification on entry and in 2006 this was 5%. It might have been expected that in 2006 more students would posses an IT qualification on entry than in 1998 as IT had increased in importance in the school curriculum. However, taking an IT qualification may be related to a student's considered ability in school, rather than being a randomly distributed attribute across the population. The accuracy of the data used in the survey is not suspect because it derived from the college MIS rather than reporting by students. It may be that some of the IT qualifications gained by students in the past were not logged on the college MIS because of the variety of qualifications available. However, it should be noted that the picture arising from the 1998 figures was replicated in 2006.

5.3.4.2 Correlations

In 1998 the Spearman correlation (see Appendix 4d) between IT input score and value added score was -0.38 (not statistically significant). It showed a weak to medium negative correlation suggesting that those with prior IT qualifications were less likely to gain higher value added scores. In 2006 the correlation was still negative, but much weaker at -0.16. This was, however, statistically significant. One interpretation of this is that the hypothesis that students with prior IT qualifications are more likely to perform better is not proved. It should be noted that students with IT qualifications on entry had higher input scores in general. However, the value added methodology should mean that a high input score should not make it harder to gain a high value added score, except for those students at the very top of the scale, for whom there is little scope to improve within the existing assessment scale.

5.3.4.3 Multiple regression analysis

In the 1998 multiple regression analysis the same picture emerges of prior IT qualification having a negative association with value added score – with a standardized coefficient of -0.2, and again not statistically significant. In 2006 the picture was clearer with a coefficient, which was statistically significant, of -9.0. It must be remembered that the 2006 figures are, however, based on only 5% of the sample.

5.3.4.4 Summary

Possession of IT qualifications prior to embarking on study appears to have a weak negative association with performance, and the hypothesis is rejected. This is an unexpected result, which is open to further exploration to attempt to replicate the results and to establish reasons by, for instance, qualitative research methods. However, this is outside the scope of this study.

5.3.5 Consideration of question 5

Is the relationship between participation in IT activities and performance affected by access to a computer outside college?

The hypothesis to be tested here is that increases in performance related to the efficiency of IT resources are greater for students who have access to IT resources outside college. Those who have access to IT outside college may find the use of IT resources is more closely integrated into their working methods. The six categories of IT access outside college listed in the student survey questionnaire (i.e. no access, sole use at home, shared use at home, public library, internet café and elsewhere outside college) have been reduced to one variable for the purpose of this analysis. This variable is "access to a computer outside college", which has a yes or no value. The findings in considering this question were inconclusive. It is unclear whether there is a relationship between higher IT use and performance for those students who have better access to IT resources outside college.

The hypothesis can be tested by looking at two aspects of the analysis:

1) The variance of those students who have access to IT outside college and those who do not.

2) The correlation between access to IT outside college and the value added score.

5.3.5.1 Variance

Looking at the variance, in 1998 those with IT access outside college on average achieved a higher value added score. The mean value added score for those without access to a computer outside college was -0.5 UCAS residual points and for those with 0.2 UCAS points. This is in line with the expectation that those with access to IT use outside college have an advantage in terms of performance. Those who had access to IT resources outside college also reported spending more time in IT based activities outside college, showing that they were making use of this improved access.

In 2006 the mean value added score for those with access to a computer outside college was 5.3 points for those without access and 7.7, providing an opposite result to 1998. This difference can possibly be attributed to the fact that those who reported having access to IT resources outside college, reported spending less time using IT resources outside than the students in 1998, implying the possibility that, although they had the resources available, they were not using them to best effect.

5.3.5.2 Correlation

In 1998, the Spearman correlation between value added score and access to IT resources outside college, showed a very weak negative relationship (-0.04) which was not statistically significant. When the Spearman correlation with value added score was carried out with the use of IT resources broken down into sub-categories, as listed above in section 5.3.1.4, there were no strong or statistically significant correlations. This suggests that there is no relationship between access or non-access to IT resources outside college and value added score. In 2006 the Spearman correlation between value added score and access to IT resources outside college was also weakly negative (-0.15) and statistically significant. A breakdown IT access into the categories listed above, for 2006, only revealed relationships which were not statistically significant and very weak, as in 1998.

5.3.5.3 Multiple regression analysis

The data on access to a computer outside college was removed from the multiple regression analysis because it was not statistically significant in either 1998 or 2006.

5.3.5.4 Summary

The picture here is contradictory, both within the data sets collected in the two years (1998 and 2006) and as a whole. The hypothesis that increases in performance related to the efficiency of IT resources is greater for students who have access to IT resources outside college, can therefore neither be accepted nor rejected. It is unclear whether there is a link between higher participation in IT based activities and higher performance for those students who have better access to IT resources outside college. There is evidence that where there is underused access to IT resources there is a negative association with performance. Further investigation may be necessary into the nature and use of the resources used and the effects on learning and performance, but that is outside the scope of this study.

5.3.6 Consideration of question 6

What is the relationship between student gender and performance?

The hypothesis to be tested here is that higher performance by students can be explained by gender.

5.3.6.1 Variance

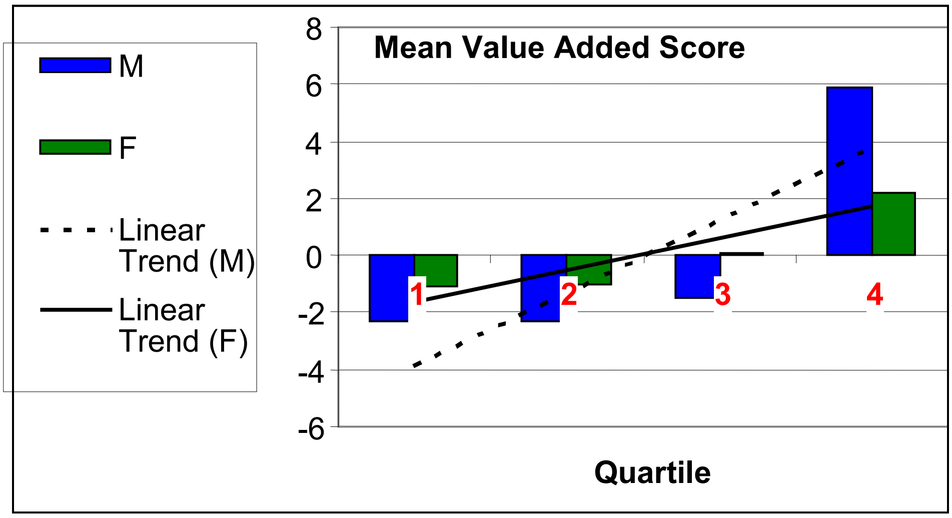
Gender is a categorical variable with two categories (male and female) and is therefore not suitable for an ANOVA analysis, although mean value added score can be compared.

Table 5-19: Mean value added score by gender

	1998		2006	
	M	F	M	F
Number in each gender group	77	111	147	201
Mean VAS	-0.0	0.2	5.2	5.7
Mean VAS for those in the lower quartile of IT use	-2.3	-1.1	6.8	5.9
Mean VAS for those in the 2nd quartile of IT use	-2.3	-1.0	8.0	4.6
Mean VAS for those in the 3rd quartile of IT use	-1.5	0.1	3.0	5.0
Mean VAS for those in the upper quartile of IT use	5.9	2.2	2.6	7.2

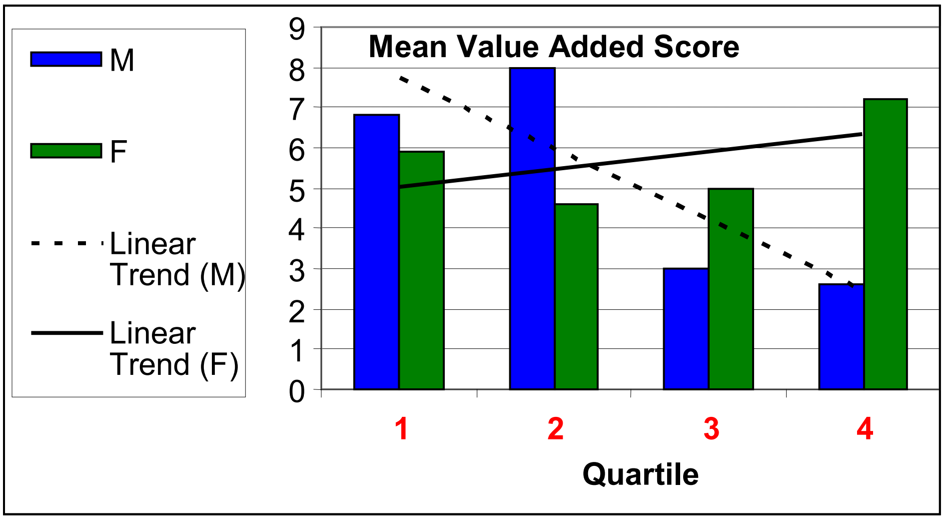
In 1998, female students as a group appear to be more likely than males to achieve a higher value added score. However males in the upper quartile of IT use had a much higher mean value added score than females, and those in the lower quartile had much lower value added scores i.e. the rate of increase was much greater. This suggests that, for males in the sample studied, engagement in IT based activities had a much stronger relationship with the value added score. This can be illustrated by figure 5-11.

Figure 5-11: Gender differences in mean value added score by IT use quartile (1998)



However, in 2006 the trend was for female students' value added score to rise slightly the more time they spent in IT with the exception of the lower quartile, but the trend for male students was that the more time they spent using IT resources, the lower their value added score. This is shown in figure 5-12.

Figure 5-12: Gender differences in mean value added score by IT use quartile (2006)



The 1998 and 2006 results appear to offer similar patterns for females, but contrasting pictures for males. It appears that one of the key differences between the 1998 and 2006 results is the performance of males. It may be that there is some attribute in the way in which males make use of IT resources which means they make a negative contribution to effectiveness, which does not apply to females. In discussing the descriptive statistics in chapter 4 above, it was observed that in both 1998 and 2006, males were more likely to be in the highest category for reporting the total time spent in all activities (figures 4-1 and 4-2). If this were true for 2006 but not 1998 it might corroborate the suggestion that there is some aspect of the way in which male students spend their time in the use of resources which contributes to effectiveness. However the descriptive figure was similar in the two surveys, suggesting that if the way in which male students make use of resources was a factor in effectiveness, it relates to a change in practice between 1998 and 2006. Further consideration of this issue needs a more detailed observational survey of the ways in which students actually make use of resources which goes beyond the parameters of this time-data analysis.

5.3.6.2 Correlation/ multiple regression analysis

In both 1998 and 2006, the correlation between the dummy variables for gender and value added score revealed no statistically significant or strong correlations. The gender variable was excluded from the multiple regression analysis because it was not statistically significant.

5.3.6.3 Summary

Consideration of gender offers differing pictures in the two years studied. In 1998, the relationship between high use of IT resources on performance is more noticeable in male students. In 2006, females appeared to show a positive association with performance, while males appeared to show a negative association. In considering question 2 it was suggested that there might be an optimum time to spend in IT based activities, and this might be around 600 minutes (10 hours). Looking at both the 1998 and 2006 data sets and then dividing them between those students who spent less than 600 minutes in IT based activities and those who spent more than 600 minutes in IT based activities reveals that the trend for female students is that their value added score increases steadily with increases in time spent in IT based activities. With male students, value added scores appeared not to change when the time spent in IT activities is increased up to 600 minutes, and after this showed a rapid decrease. Looking at the 1998 data alone, both males and females showed a big decrease in value added score once than 600 minutes were spent in IT based activities, whereas in 2006 females continued to show an increase in value added score even when more than 600 minutes were spent. However, it should be pointed out that the number of female students spending more than 600 minutes in IT activities was only 3% of the data set, and so this apparent trend should be treated with great caution.

It is not clear whether the hypothesis can be accepted. There was a slight degree of variation by gender in 1998, but a marked degree in 2006. The results are however complex and unclear. The existence of gender differences appears to show that there is a relationship between gender and value added score, which can distinguishable from the use of IT resources.

5.3.7 Consideration of question 7

What is the relationship between student ethnicity and performance?

The hypothesis to be tested here is that higher performance by students can be explained by differences in ethnicity.

5.3.7.1 Variance

Any possible relationship between performance and ethnicity needs to be accounted for in the analysis. This can be done by looking at the variance in the mean value added score for the different categories. This is set out in Table 5-20.

Table 5-20: Ethnicity variance

	1998				2006			
	Asian	Black	White	Other	Asian	Black	White	Other
Number in each gender group	154	33	14	28	274	37	12	24
Mean	0.5	-0.9	-0.2	-0.6	4.6	10.2	2.5	9.8
Mean for those in the lower quartile of IT use	-1.6	-1.9	-2.0	-0.7	5.6	8.3	-4.0	11.7
Mean for those in the 2nd quartile of IT use	-1.8		-0.5		4.1	24.0		9.1
Mean for those in the 3rd quartile of IT use	-0.5				3.3	17.0	2.2	10.1
Mean for those in the upper quartile of IT use	4.8	0.3	0.0		5.5	3.0	7.7	7.7

I have focussed on those ethnic categories where there is a large enough sample for the figures to be meaningful. In 1998, Asian students were more likely to get higher value added scores. When categorised by quartile of IT use, the same picture emerged. For both Pakistani and Bangladeshi students the only groups of students with a positive mean value added score are those in the upper quartile of IT use. In 2006, the Asian group consisted of a greater proportion of the population, meaning that the other groups were relatively small sample sizes; however, the “black” and “other” groups appeared to perform the best. Dividing the populations up into quartiles of time spent in IT activities did not create any clear patterns.

5.3.7.2 Correlation/multiple regression analysis

In 1998 the analysis showed that the correlations between the dummy ethnicity variables and the value added score was in all cases weak (ranging from -0.09 to 0.14) and not statistically significant. In 2006 the correlations were again weak (ranging from – 0.17 to 0.16), but did show as being statistically significant. The ethnicity variables were omitted from the multiple regression analysis as non-significant.

5.3.7.3 Summary

Ethnicity was discounted as factor in performance. The figures for the variance in the means show some indication that with certain ethnic categories there might be a positive association with value added score; however, any relationship was shown by the correlation and regression analyses to be neither strong nor statistically significant.

There is a danger in drawing firm conclusions from the ethnicity data as even with the amalgamated categories, the categories are small. In addition, ethnicity may be seen as an inadequate proxy for other factors such as language skills which are beyond the scope of this study. A larger study in which there is a higher population in all the ethnicity categories may well be able to provide clearer answers to this question.

5.4 Conclusion

The general hypothesis of this study is that the use of IT resources has a positive assoociation with performance. In order to test this, a series of questions were posed.

The main hypothesis –*that there is a stronger interrelationship between engagement in IT based activities and the performance of students than non-IT based activities* – cannot be accepted. For the 1998 data, a general trend was observed in each of the three methods of statistical analysis used (variance, correlation and regression), which showed that the more time a student spent in any learning activity, the more likely they were to achieve a higher value added score. While this might be expected, the trend was more pronounced for IT based activities than for non-IT based activities. Taken on its own, the 1998 data confirmed the thesis. In 2006 the picture was less clear. It suggested that performance was not improved by increasing the amount of time spent in either IT or non-IT based activities. Those students who spent less time in either type of activity had better scores. There are some suggestions to explain this apparent puzzle, which were considered in the context of the other questions, such as the ways in which resources are being used, particularly in the context of gender. This variation may also be attributable to factors not identified or analysed in this study.

In 1998 a comparison of the variances between groups representing the different bands of engagement in activities showed that the differences in value added scores between those who spent most time in IT based activities and those who spent the least were greater than the differences between comparable groups engaged in non-IT based activities. By comparison, in 2006 the differences between groups were smaller with an apparently opposite trend. The 1998 data showed a stronger statistically significant correlation between time spent in IT based activities and value added score than for time spent in non-IT based activities and value added score. There were no strong or statistically significant correlations in the 2006 data. A regression analysis of the 1998 data showed that the relationship between IT based activities and value added score was statistically significant, large and positive, whereas that of non-IT based activities was neither statistically significant nor large and was mostly negative. This was not shown for the 2006 data.

The conclusion from the analysis of the 1998 data is that time spent in IT based activities appears to have a more effective association with learning, as assessed by the value added measure of performance, than time spent in non-IT based activities. This conclusion could not be drawn from the 2006 data. These data suggested the opposite proposition: that use of IT resources harmed performance. The 2006 data was, however, less clear and there were issues over the reliability of some of the time data reported by students.

The remaining research questions addressed ancillary issues.

Question 2 explored the issue of whether the relationship between IT based activities and performance can be distinguished from the general level of "hard work" by the student. The analysis distinguished from the "IT" aspect of activities and the "time spent aspect". In 1998, it was possible to separate these aspects and conclude that although location and time spent in general were important factors influencing the effectiveness of study, time spent in IT activities was more effective irrespective of whether the student worked hard or not. In 2006 the opposite appeared true, the relationship between IT resource use and performance could not be distinguished from that of "hard work" by the student.

Question 3 addressed the issue of whether any association between the faculty in which a course was studied and performance can be discounted. Some faculty categories showed a stronger association with value added scores than others, notably Business Studies in 1998; however, the subject areas were different in each data collection. In 1998, business studies appeared to show an association but this was not repeated in 2006. Instead IT as a curriculum subject appeared to show an association. These associations did not appear related to the findings of research on the relative difficulties of different subjects. It is difficult to distinguish the relationship between the faculty category in which the subject was studied and performance from that of engagement in IT based activities. It may be that the factors which appear to show a relationship between subject or faculty and performance are transient factors such as the input of a particular member of staff or teams, rather than aspects of the subject itself, or factors connected to institutional organisation. Further study into this is possible, for instance observation of teaching practice but is outside the scope of this study.

Questions 4 and 5 addressed the issue of whether of the relationship between IT provision at the college and performance can be distinguished from that of IT resources not provided by the college. As the study was concerned with the impact of resources in college, any improvement in performance associated with IT needs to be distinguished from any prior use of IT resources or IT resources provided elsewhere. In both 1998 and 2006, the analysis showed that prior use of IT, evidenced by the possession of an IT qualification had a weak negative association with performance. This unexpected finding might be explained by factors such as the way in which the colleges have recorded prior qualifications, or by a process of selection which meant that only students of particular attributes had IT qualifications on entry, which may be reflected in the performance figures gathered for this study . In both 1998 and 2006 access to a computer outside college did not show a clear relationship with value added score. What association could be discerned was negative in 1998 and positive in 2006, but in both cases was very weak.

Questions 6 - 7 addressed the issue of whether the relationship between IT use and performance can be distinguished from aspects of students' personal characteristics, specifically gender and ethnicity. In 1998 males appeared to have better performance figures, but this was not consistent across all categories of IT use. The opposite was true in 2006, with females performing better. The association between gender and performance was very marked in 2006, with males appearing to be a key factor. Ethnicity showed no clear relationship with value added score in either 1998 or 2006.

In summary engagement in IT based activities in 1998 appeared to have some association with performance but this was not clearly replicated in 2006 and so no firm conclusions can be drawn.

6 SUMMARY AND CONCLUSIONS

The focus of this study has been the development and exploration of a technique of "individual time-data analysis" (ITDA) as a tool for use in evaluating the effectiveness of the different resources available to students. This tool is aimed at the type of analyses required in situations where differentiation in resource use by students varies at the student level. The study explores an underdeveloped area in methods identified in the literature. The tools established through this study of the use of IT and non-IT resources by students in a West Midlands college could be applied and further developed through use in different educational situations.

6.1 ITDA and effectiveness studies

A review in Chapter 2 of the literature on effectiveness over the last thirty years has shown that earlier studies either fell within the ambit of school effectiveness studies which looked at institutional factors in effectiveness or they focused on the effectiveness of specific interventions in the education process. More recent studies have explored the effectiveness of educational processes, with increasing detail and sophistication. These have also been discussed in Chapter 2 and again in Chapter 3 in the context of methodology where they have been placed within the framework of the intersecting spectra - complexity and intervention - illustrated by Figure 3-1. This study builds on this body of literature.

Developments in education have been driven, over the last thirty years, by government initiatives for school improvement based on the school effectiveness paradigm. This has led to pressure on educational practitioners to make regular evaluations of the effectiveness of those aspects of the educational process which are within their control. The use of resources, particularly in the ever-developing field of IT, is one of these aspects. At the same time, those responsible for resource management at the class or department level often have least time available to evaluate the effectiveness of their resource use. Methods of evaluation of effectiveness which are available to practitioners at this level are scarce in the literature. Practitioners, as opposed to institutional managers, do not have control over strategies at the whole institution level on which school effectiveness research is based. Neither do they have the time or resources to carry out intervention studies to evaluate the effectiveness of new resources. The development of IDTA in this study attempts to explore a new method of evaluation of resource use which can be made available to practitioners. In terms of the intersecting spectra illustrated in Figure 3-1, this study was small scale, but capable of aggregation, and required minimal intervention on the part of the researcher. The study was developed in this way with the constraints on educational practitioners in mind and includes the selection of methods and limited time required to apply them. These methods, by being capable of aggregation, can be scaled and repeated to provide a longitudinal aspect to the evaluation of effectiveness. A series of surveys can provide snapshots of effectiveness. This is important when the effectiveness of IT resources is being evaluated, where there is a typical replacement schedule of three years. Where there is differentiation in resource use at the student level, methods involving the comparison of groups, such as those used in intervention studies, are not helpful. It is difficult to measure the relationship between the use of different resources and performance outcomes. However, the time spent using the resources and particularly the proportions of time spent using them becomes a measurable proxy for this. This, therefore, was the focus in the development of the practitioner-friendly ITDA technique.

6.2 Developing the methodology

6.2.1 Methods used in ITDA

The study consisted of an investigation in which an example of ITDA was formulated and applied. The following methods were used.

1. The research questions to be investigated by the time-data analysis were formulated with reference to school effectiveness and associated literature. In the case of this study, the questions were formulated to investigate the relationship between IT resources and students' performance and to distinguish any interrelationship between IT resources and students' performance from that of non-IT resources and other student-based factors.

2. A college and a group of students were chosen as subjects of the study. The selection of a college was based on a shortlist of colleges displaying good practice, although the final selection was made largely on grounds of practicality, once access issues had been resolved. Students were chosen from a cross-section of classes across the college.

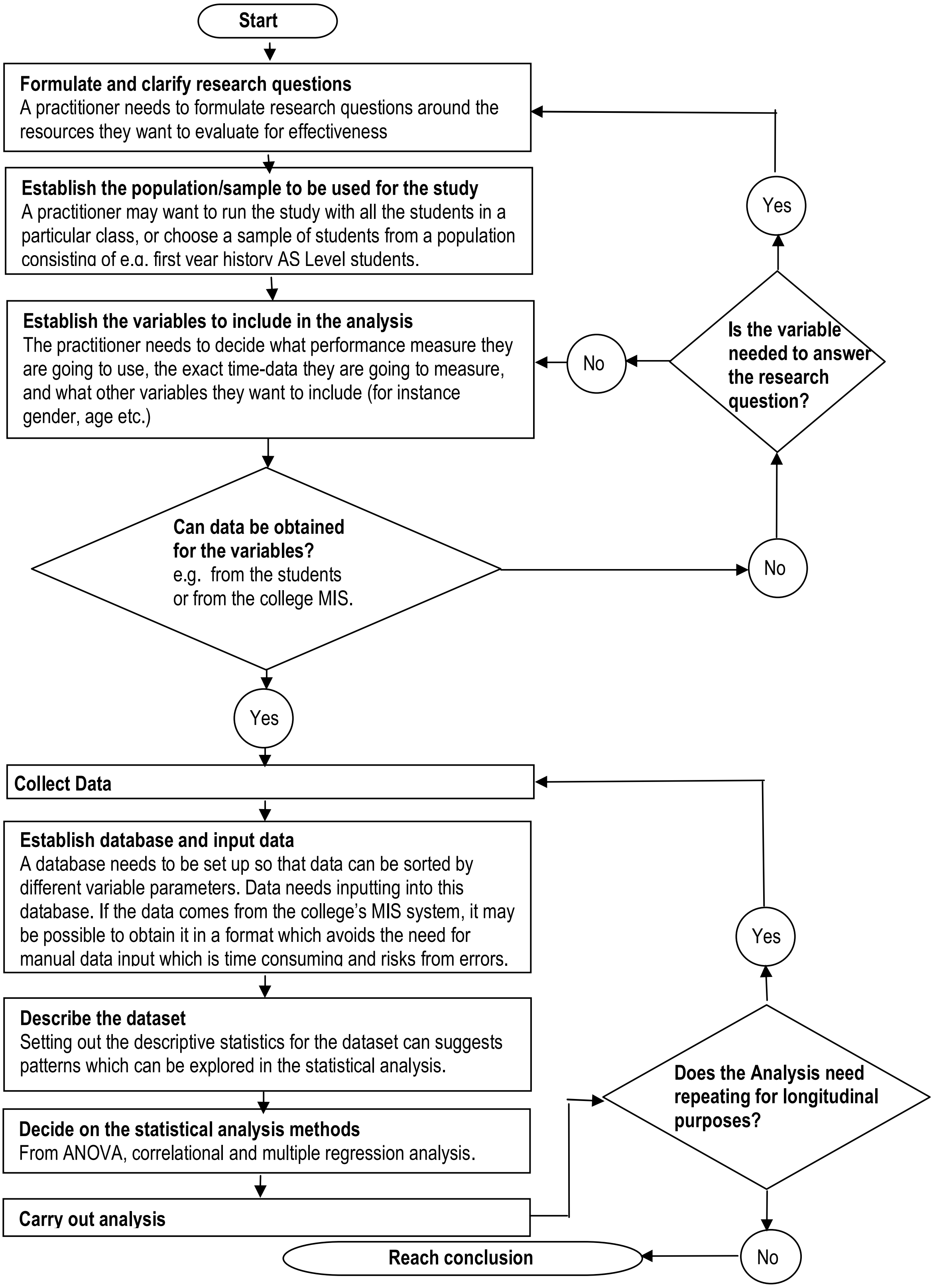
3. A survey of students' use of a variety of IT and non-IT resources and facilities was taken for each subject that students studied. In 1998, the researcher was present to explain the questionnaire to classes which consented to the survey. In 2006 the students were chosen at random according to selection criteria chosen by the researcher, who submitted a written explanation of the survey to the college staff who administered the questionnaire. Performance in each subject studied in college was assessed separately by the examination system. The relationship between the use of resources and the results of that exam needed to be treated separately. Each student therefore reported separately on their use of resources for each subject. There were two data sets for 1998 and two for 2006 one relating to student factors, such as gender and ethnicity, and a second based on "student subjects" which related to factors such as performance and the use of time.
4. Data were collected from the college on the students' performance for each of the subjects they studied. This information was cross-referenced with the information provided by the students in the time-data questionnaire. In 1998, because of data protection and access issues, returns from the survey had to be matched up with student data from the college MIS by the researcher, and some questionnaires could not be matched. In 2006, problems of confidentiality were resolved by having the college select the students at random for the survey and extracting the other information from the college MIS on those same students.
5. An analysis was carried out using statistical techniques including a comparison of the variances between groups, correlation analysis and regression analysis.

6. The process was repeated after a number of years to give the study a longitudinal aspect.

6.2.2 Summary of the individual time-data analysis model

The IDTA method used by this survey is set out in the flow-chart overleaf (Figure 6-1). It is set out in generic terms and it is suggested that this method could be applied by practitioners in schools or colleges and could suit a variety of questions.

Figure 6-1: Steps in the model (to be repeated if a longitudinal aspect is required)



An example of how this might be applied is set out below.

A college faculty manager has an equipment budget. Several of the staff in the department have been on a seminar on the use of gaming consoles in the classroom and have requested the development of a “gaming suite” where students can learn through the use of educational games. The faculty budget is limited and the setting up of this room would take funding away from the funding of other resourcing needs such as laptops which need replacing and paper-based materials which need renewing with each year’s intake. The manager must make a strategic funding decision. S/he decides to purchase a few consoles which will be located in a corner of an IT suite to evaluate their effectiveness, before committing to the setting up of a dedicated “gaming suite”. The students will use this resource on a drop-in basis. S/he can use ITDA to evaluate the educational effectiveness of the students’ use of the gaming consoles.

Step	**Actions**
Formulate and clarify research questions	The manager wants to know, in general, the effectiveness of the use of gaming consoles. S/he will, therefore, want to ask: 1. Do students who spend a greater proportion of their time using the gaming consoles achieve better value added results? This corresponds to research question 1 in the study above. Some consoles involve using different techniques than others, and each uses different games. S/he may wish to ascertain which particular resources are worth investing in. S/he may therefore ask:

2. Is there a relationship between the type of console used and performance?
3. Is there a relationship between the software and performance?

Establish the population/sample to be used for the study

The manager needs to decide whether to survey all users of the resource or pick a sample. The demand on the resource will determine the sample size. If s/he decides to select a sample s/he needs to establish, for instance, whether s/he wants to use a random sample or one targeted within certain parameters (e.g. those on a particular course).

Decide on what variables to include in the analysis

The manager will need to include a time data variable and a performance variable. The time data variable can be broken down into categories, determined, for instance by the type of console used or the software used. S/he then needs to decide whether data on other variables need to be gathered; for instance, s/he may think gender is a factor s/he needs to take into consideration, or s/he may want to know whether use of gaming consoles at home is an issue relating to effectiveness of their use as an educational resource within the college.

Check the data-sources for the variables

The manager needs to decide where the data for his variables will come from. S/he will be able to obtain student data from the college MIS and performance data from faculty records or the college MIS. To obtain time data s/he may be able to look at booking records for

	the IT suite in which the resources are located, or s/he may have to devise a questionnaire, relying on students' self-reporting of their use.
Establish database and input data	Having gathered the data the manager needs to load this in a database.
Describe the data set, decide on the statistical analysis methods, carry out analysis and reach conclusion	Once the data have been gathered and entered into his database, the manager can describe patterns of use, which may help in his analysis. S/he can then analyse the data statistically and reach conclusions

Once s/he has carried out his ITDA analysis, the manager can make a decision about the funding of the new "gaming suite". S/he may also be able to mount an argument based on his research to obtain extra funding. It should be noted that the ITDA process will need a period of time to carry out. The students will need to use the resources for perhaps six months before the analysis is carried out, in order for their use to have an effect. It may be that the manager will need to wait until performance measures, for instance exam results to become available. After this, time will be required for analysis. A longitudinal aspect – a review of usage some time later - may also be required to establish whether the first survey's findings are consistent.

6.3 Longitudinal aspects to the study

6.3.1 Importance of having two or more surveys

A study which seeks to explore new developments in the range of effectiveness studies in education needs to ensure that the methodology can be re-used. When two or more surveys are carried out, by definition there will be differences in the population surveyed, otherwise they could be regarded as part of one survey. In the case of this study, the two surveys could have taken place at the same time, but with populations that differed by location or institution, such as two colleges surveyed at the same time. This would show a more generalisable snapshot of the college population at the time of the survey, which could distinguish institutional factors. Such a survey is more common in the school effectiveness literature, and has the advantage that it takes less time to reach a conclusion; however the need for longitudinal analyses has been noted in both the literature on school effectiveness (e.g. Griffifth, 2002, which saw a single snapshot as a limitation) and on IT use (e.g. Cox and Marshall, 2008). In this study, the difference between the two surveys was longitudinal, carried out in 1998 and 2006. The difference between the two populations surveyed was across time, rather than different institutions. The advantage of this variation is that, although the conclusions are not tested for generalisability across institutions, the method is tested to show its robustness across changing circumstances in a rapidly developing area such as IT. Although this provides the opportunity to use experience gained in the first survey to improve the efficiency of the second, it is important that the same type of data are gathered in each survey so that the same variables can be used in the analysis, allowing the substantive results to be compared. In the case of this study, the two results appeared to contradict each other: the hypothesis that IT makes a measurable positive contribution to performance was accepted for 1998 but rejected for 2006.

The difference in conclusions between the 1998 survey and the 2006 survey strengthens the case for retaining a method that is applied at different times as the finding draws attention to the need for caution in making conclusions from one set of results. In the case of this study, the first survey would lead to an acceptance of the hypothesis, which was not replicated in the second. If the results from 1998 had been used to formulate policy in the college, then inappropriate decisions may have been taken as to investment in IT resources. A longitudinal evaluation allows for the cumulative effect of investment to be carried out. In the particular case of IT resources, a longitudinal study is useful, because of the need for periodic replacement of IT resources due to typical replacement schedules of around three years. The gap between the two surveys in this study was eight years, which was due in part to the development of the analysis methods used. In retrospect, this gap was too long, leading to issues of comparability which are discussed below. A better gap would be the three years which represents a typical replacement schedule for IT resources.

The longitudinal aspect of a two-survey study means that consideration must be given as to whether the two surveys give a coherent picture. The two surveys were snapshots of the contribution to effectiveness of IT resources at this particular college and can help form an idea of the changing contribution to effectiveness of IT resources over the period. An analogy might be with the inspection process whereby government agencies investigate and judge the effectiveness of colleges through inspection visits. In the period of this study the college was inspected in 1998, 2001 and 2006. The inspection process uses an entirely different methodology to this survey but is analogous in that the progress of the college is assessed through a series of snapshots based on short periods of time: inspection visits take place over two or three days. The more frequent the snapshots, the easier it is to form a clearer impression of the development of the college. This can be borne in mind in any subsequent survey which uses the methodology developed in this study.

6.3.2 The two surveys in this study

A number of factors distinguish the two time periods in which the surveys were undertaken in this study. Firstly, over the eight years separating the 1998 and 2006 surveys, the level of acceptance of IT resources has increased. Factors driving this include costs and availability and the development of a habit of IT use. Over the last four decades, the power of IT resources has increased exponentially (following Moore's law – Moore, 1965) and, at the same, time costs and availability of IT resources have dropped dramatically. In addition, cheaper processing power is incorporated into more devices, which are more widely used. In addition to this, newer technology incorporates and builds on the functionality of older technology. Personal computers in 2006 did the same things as personal computers did in 1998 but added extra functionality. Personal computers in 1998 allowed users to create word-processing and spreadsheet documents, search for information on the internet, communicate by email and so on. Computers in 2006 still allowed users to carry out these functions but with greater speed and efficiency, whilst also allowing users to carry out new tasks. An example of this is that the internet in

1998 was accessed, for most users, by slow dial-up connections. Text and pictures could be accessed, but information which required greater band width, such as audio or video streaming was not practical and therefore not widely available. By 2006, most access to the internet was via broadband connections at college and increasingly so for students working at home, and a host of audio and video streaming applications became available to utilise this. These new functionalities added value to IT resources and their attractiveness and ubiquity in society, but acceptance was also increased because the functionality available in 1998 was more familiar after eight years of use; a user who first used email in 1998 will have had eight years of use by 2006. Secondly, and particularly relevant to the populations targeted in this survey (16 to 19 year olds) the eight years separating 1998 from 2006 represents nearly half their lives. Whereas an older user of IT resources can remember a time when they were not available ("immigrants" to the digital age (Prensky, 2001 pp. 2-3)), the students of 2006 have spent most of their lives in a world where IT is available and accept it as a natural part of that world. An example here might be the use of mobile phones. In 1998 ownership of mobile phones in the UK had not quite reached saturation – there were some people who might have found them useful who still did not possess one. This had changed by 2006. The 16 to 19 years olds in the 2006 survey have spent their childhood in a world where it is normal for adults to have a mobile phone. This distinguishes the college population of 1998 from that of 2006, because the contribution of IT use to effectiveness in education may, for instance, be related to its former status as a special and an out of the ordinary resource which attracted a student's attention. The relationship of the novelty factor of technology to learning is an area which merits further research.

Related to changes in the level of acceptance and availability of IT resources are changes in their use within colleges. The introduction of interactive white boards, cheap laptops and Personal Digital Assistants (PDAs) using wireless networks with broadband connections, means that IT use became far more widespread in colleges and classrooms between 1998 and 2006.

Another factor which distinguishes the 1998 college population from that of 2006 was a general improvement in the education provided by the college over that time period. This is evidenced by comments in the inspection reports, already noted and corroborated by the fact that, in this study, the mean value added score for the lowest performance quartile in 2006 was greater than for the highest quartile in 1998. The association between IT resources and performance may be stronger when the student has a lower starting performance score than when this is higher. This general improvement means that the contribution of IT resources to effectiveness applies in a different learning environment.

6.4 Evaluation

6.4.1 Revisiting the literature

In Chapter 2, a review of the literature on effectiveness and on IT resource use revealed a varied and developing pattern. Blass and Davies (2003 p. 243) noted that "There is yet to be a clear and unconflicting body of evidence as to what works and what does not". Cox and Marshall (2008) noted that the study of the effects of IT on learning has not led to an unequivocal body of knowledge on what works. With the literature revealing no clear consensus as to how IT resources can most effectively be used, it was never anticipated that this study could agree with or contradict any consensus view. There follows a comparison of the findings of this study with the existing literature.

This study explored the general question as to whether the use of IT resources had a measurable positive association with the performance of students. In 1998, the analysis concluded that time was spent more effectively when using IT resources than other resources. The time spent using IT based resources appeared to make a greater contribution to the student's value added performance. In 2006, however, the picture appeared to lead to the opposite conclusion. Those students who spent the greatest proportion of their time in IT based activities were less likely to achieve higher value added scores, suggesting that engagement in IT activities was a negative association with performance. The question of whether the use of IT resources has a positive or a negative association with performance, has been addressed widely in the literature and, although there is no consensus, the balance of studies tends to suggest a positive effect. This applies across all sectors of education, from primary to university level. However, the majority of studies, rather than focusing on the division between the two general categories of IT resources and non-IT resources have tended to investigate more specific resources. For example, Rau *et. al.* (2008), investigating mobile communication technology in high school education, compared the use of email, online forums, Short Messaging Services (SMS) and no use of any digital communication format. The study concluded that when mobile communication was combined with the internet, the private communication channel used avoided pressure and aided motivation, and so was more effective. Grabe and Christopherson (2008) compared different forms of online resources and found that text-based resources were more effective than audio recordings. Park *et al.* (2009) Sun *et al.* (2009) and Papastergiou (2009), investigated gaming or simulations and concurred as to their benefits. De Lucia (2009) carried this a step further and found benefits in modelling the whole university experience in a virtual campus using the "Second Life" online environment. Selwyn and Gorard (2003), however, found that enthusiasm for the use of IT resources was overblown in the further education sector, because it didn't increase motivation for learning. In the study in this thesis, data was gathered on a variety of IT and non-IT resources but, for analysis, it was necessary to aggregate categories into IT and non-IT resources, because of issues of co-linearity. Some studies included non-IT resources amongst a variety of IT based resources for comparison. Evans (2008), evaluating the effectiveness of "M Learning" (the use of mobile devices for listening to "podcast" learning materials) reported that students found "podcasting" to be a more effective learning tool than traditional means such as written notes a finding corroborated by for example McKinney *et al.*(2009). However, as was noted in Chapter 2, that study did not base its effectiveness criteria on externally tested outcomes, but on student perceptions. Lopez-Fernandez and Rodriguez-Illera (2009) found that student perceptions of the effectiveness of the method was high, but that the impact on their learning was insignificant. Segers *et al.* (2004), comparing stories read by teachers to primary schools pupils with stories delivered by computer, found no clear relationship between the use of the IT resource and their pupil's literacy skills, except in the case of immigrant (non-native speaker) children. Spector (2005) comparing different instruction methods, (online: email, threaded discussion forums, online chat sessions, course websites and face to face lectures) found that online learning was not inherently inferior or superior to traditional face to face learning. Connolly (2007), however, noted the greater effectiveness of IT resources as opposed to face to face teaching in university students. The contradictory findings of this present study are broadly in line with the equivocal message on the effectiveness of IT resources from the literature.

Having addressed the general issue of whether the use of IT resources had a positive or negative association with performance, this study then went on to consider whether this could be distinguished from that of "hard work". In the1998 survey it appeared possible to distinguish the relationship between the use of IT and performance from that of general level of hard work but for 2006 the opposite was the case. This is an aspect which has not been addressed to any large extent in the literature, and so it is difficult to assess whether the results of this survey are in line with the literature. Some reference to this issue has been made in the studies referred to in the literature chapter, but it has not been the main focus of the studies. Spector (2005, p. 11), summarising the literature on predicting learning outcomes, noted that "A well-established predictor of learning outcomes is time on task", but did not distinguish between time on task and hard work. He did note that students on higher level courses were more likely to spend longer on task. Much that has been written in this area concerns distractions surrounding the use of IT resources in self-regulated study. Blass and Davies (2003) noted that students who have PCs in their rooms often regard them as a means of entertainment rather than a means of learning and noted the need for adequate assessment of whether learning has taken place: "it is not simply a question of the amount of time the student has been exposed to e-learning, but have they utilised what they have learned" (p. 243). Conole *et al.* (2008), in reporting student perceptions of learning resources, noted student concern about "frequent interruptions" when using instant communication resources. Fried (2008) in a paper discussing laptop use in class, identified their multi-tasking capabilities as being a distraction. It has also been noted that these interruptions are countered by student motivation in self-regulated learning environments. Van Grinsven and Tillema (2006, p.87) noted that "students in self-regulated learning environments are motivated to learn, report more enjoyment of the material and are more actively involved in their learning than those who study in more restrictive environments". Wittwer and Senkbeil (2007) found there was no link between use of a computer at home and performance in maths, unless that use was appropriately targeted; that is to say the students were motivated and on task. The study acknowledged the difficulties in measuring how students use IT resources at home. Nævdal (2007) noted that for female students there was a relationship between the amount of time spent using a computer at home and performance in English (the language of the internet, but a foreign language to the students in the survey) and was a peak in this effectiveness at two hours a day. In this present study, a potential peak was also noted in the discussion on the ways in which IT resources are used outside college may be related to effectiveness, but that this requires further research.

This study then went on to consider how the choice of subject was related to the effectiveness of IT resources. In both 1998 and 2006, it was shown that the faculty in which a subject was studied had a weak association with performance but that different faculties demonstrated this in the two surveys. That the subject studied, or the faculty in which a subject is studied, shows some association with performance is broadly in line with the literature. For instance, Kyriakides and Charalambous (2005), in a multilevel analysis of effectiveness, reported that there was a noteworthy variation in student performance by subject at the class level.

The next item to be considered was whether possession of IT qualifications prior to embarking on the A-level programme and whether access to IT resources outside college had any relationship to performance. The literature reported here has a tendency to look at access to IT together with and prior qualification and existing skills. Ballantine (2007), investigating the reliability of self assessment as a means of assessing competence in IT use, found that reported prior use of IT resources did not change the reliability of self reporting. Selwyn and Gorard (2002), investigating non-participation in adult learning, found that most non-participants reported other reasons for their non-participation, other than lack of access to IT resources or the knowledge of how to use them. Colley and Comber (2003) noted that secondary school age girls in the UK report less access to IT resources at home than boys. The study does not relate this to performance but national statistics show that in the same period as the Colley and Comber study, girls out-performed boys. On the other hand, for instance, Blass and Davies (2003), in suggesting criteria for implementing “e-learning” strategies, identify lack of IT skills and access to IT as a potential problem in learning. This present study concluded that possession of an IT qualification showed a week negative association; however, it is unclear whether there is a relationship between higher participation in IT based activities and higher performance for those students who have better access to IT resources outside college.

There is evidence that, where there is underused access to IT resources, this has a negative association with performance. These results are not inconsistent with the literature,

Lastly this study considered whether the effects of gender and ethnicity could be distinguished from the effects of using IT resources on performance. In 1998 the relationship between the use of IT resources and performance was more noticeable in male students. In 2006, for females there appeared to be a positive association, while for males it appeared to be negative, although this outcome was entirely accounted for by a few students who reported spending a long time using IT resources. The study appears to show that gender has an association with value added score, which can be distinguished from the use of IT resources. This is directly in line with the findings of Nævdal (2007) that for students spending two or more hours a day using a PC at home, girls performed very well in English but this was not evident for boys. Papastergiou (2009), investigating the use of gaming in class, found that there were gender differences with male students engaging more effectively with the method, although they did not show any noticeably increased performance.The literature on gender has often focused on access and use issues; for instance Colley and Comber (2003), rather than the relationship between use and performance differentiated by gender. Colley and Comber (2003) report in their survey data the fact that boys are more likely than girls to have access to a games console as opposed to a PC,. A games console can only be used for playing games, whereas a PC is dual use, suggesting that the gender differences reported might be attributable to the greater attraction of computer gaming to boys, and a consequent disassociation or distraction in boys from the use of IT resources for learning. Van Houte (2004) noted that differences in performance between school-age girls and boys can be attributed in part to their different "culture" and attitudes to learning. In this present study, Ethnicity as a variable showed no relationship to performance that could be distinguished from the effects of using IT resources. Where the literature discusses ethnicity, it is often in the context of the relationship between language skills and learning (Segers *et al*., 2004). There is no clear consensus on the relationship between of ethnicity and IT performance.

To summarise the discussion above, the literature does not present a single clear message about the effectiveness of the use of IT in education. Rather, the literature shows that the study of effectiveness in this area depends on a great many different factors. This present study largely concords with this.

Having considered how the current study accords with the literature, further evaluation is required as to its limitations. This follows below, preceded by a consideration of the practical difficulties faced by the study.

6.4.2 Practical difficulties

The study faced a number of practical problems, many of which were related to its nature as a PhD study which was carried out by a researcher external to the college in which the study took place.

The first issue is access. A number of colleges were approached to participate in this study, a small number of which proved initially cooperative but changes in personnel at colleges meant that contacts were lost. The obstacles to cooperation by colleges included the need to avoid disruption to the work of the college and concerns about confidentiality, although these latter concerns were resolved.

The second issue was matching data. A number of records in the sample used had to be rejected because they could not be matched with student records obtained from the college. Although a unique ID – the student's college ID number - was requested on the questionnaire, this number could not always be matched with a record on the student data set obtained from the college. The reasons for this included missing or undecipherable ID references on the questionnaire and an ID in a format which did not match with the format used on the college's MIS system. In addition a number of records had to be rejected from the analysis because, although there was a time-data questionnaire for a student, there was no record of their performance on the college's MIS. This was usually because the student failed to complete the course. If there was no end qualification data available, no value added performance figure could be produced. The value added performance figure was vital to the analysis, forming the dependent variable. Where a student had no value added score, it is difficult to ascertain the relationship between IT use and performance. The student may well have learned something in their time at college, using the resources, but this was not measurable using the quantitative methods developed for ITDA.

These problems were addressed in the 2006 study. The college agreed to select students at random using criteria provided by the researcher. The college then pre-populated those sections of the questionnaire relating to the student's identity from the college MIS, eliminating potential mismatch between the student's reporting of the course they were studying and the records held by the college used to identify the student's results.

The third issue is related to the reliability of the data reported by students. Although great care was taken to explain to participants what was required, not all the time data reported by the students appeared realistic. There were two problems. The first was over-reporting of the time devoted to each type of activity. This was dealt with by applying a control on the data received: one part of the questionnaire asked the students to report how much time in total they spent in study each week and subsequent questions asked students how much time they spent in each type of activity. The total for individual activities was often greater than the time reported in the "total time" question. To address this, an approximation of time on different activities was reached by dividing the total time in proportion to the times reported for the individual activities. This is also explained in a footnote to Table 4-14. Another problem with the reported data was revealed by the data collection in 2006. It appeared that some students were not reporting accurately, as some reported that they spent no time in IT or non-IT activities in class. Possible reasons why this was the case include the fact that they were attributing their time in class to another type of activity which was not included in the survey; because they were accurately reporting the fact that they do not attend class; or even because of their failure to understand what was required by the questionnaire. This may have contributed to the lack of a clear picture in the 2006 data; however, removing these students from the analysis did not change the results in any meaningful way. In 1998, the requirements of the survey were set out by the researcher in person but, in 2006, this was done by college staff using the written instructions of the researcher. It may, therefore, be advantageous for the researcher to administer the questionnaire in person.

Between 1998 and 2006 the questionnaire was revised with minor changes, but it was thought necessary to keep the principal parts of the questionnaire in order to ensure that the data gathered provided the same variables for the analysis. Other possible changes designed to improve the questionnaire are discussed in the next section.

6.4.3 Study limitations

The practical difficulties, outlined in the previous section, along with the limited scope of a PhD study, mean that this work has a number of limitations.

The first issue is the use of self-reporting of time by students. This method was used for practical reasons but, as has been noted above, it led to a number of difficulties about the accuracy of the data. Practical considerations meant that it was not easy to go back and question the accuracy of the data reported with the student concerned. Some of the dubious data collected had to be rejected. The formula used to compensate for a general over-estimation of time spent meant that the analysis did not use raw time data, as a result of which some genuine time data may not have been accounted for in the analysis; for example, a student may have accurately reported that they spent 10 hours at home using the internet for college but this may have been reduced in the analysed data set because they had inaccurately reported a total time, leading to a proportional reduction in the 10 hours reported.

Secondly, in relying on student reporting of time-data, I have used “time spent on a task” as a proxy for work carried out. While this is in line with the literature, it does not make any allowance for the quality of the time spent in using different resources. This is of particular relevance with reference to the use of IT resources at home, where a PC in a student’s bedroom has a dual use, as a learning tool and recreational device. This made the analysis of question 2 difficult, where an attempt was made to distinguish time spent in using IT resources from “hard work”. The need for development of the ITDA techniques to incorporate an element of quality is discussed further in the discussion on areas for further research.

Thirdly, with regard to this survey, practical difficulties meant that the sampling method used, including the selection of a college, the students and the subjects included strayed from the original intention. While the sample used was valid, the availability of respondents, particularly in the first survey in 1998, meant there was greater variation in the subjects included than originally intended. In addition the samples sizes were smaller than the ideal. This is a limitation as regard the study’s own substantive findings but the other purpose of the study was to explore the use of the ITDA technique and provide a basis for practitioners to build on in using ITDA in their own effectiveness analyses. Those carrying out their own studies and analyses developing ITDA will not be affected by the sampling issues in this present study.

Fourthly, the data gathering method, the questionnaire, could be improved in future studies. Although minor changes were made between 1998 and 2006 to improve the instrument, it was felt that the questionnaire should remain largely the same in order to provide consistency. The categorisation of resource use in the survey was relevant in 1998 but may have been slightly dated by 2006. In addition, the questionnaire could be simplified, as in practice it possibly proved difficult for students to follow. An avenue for development in any future study using IDTA is to put the questionnaire online, and encode error checking functions into it, to help to remove the difficulties with data-gathering listed above.

Lastly, while it was felt important to include a longitudinal aspect into the study, the eight years between the two surveys was possibly too long. Too much had changed both within the college and in the provision and use of IT resources in that time. A period of three years between surveys is recommended for reasons stated earlier in the discussion of longitudinal aspects.

Despite these limitations, the ITDA techniques developed in this study still provide a useful model which can serve as a basis for future studies, as set out in the flow chart in Figure 6-1, particularly in the situations discussed below in section 6.5.

6.4.4 Individual time data analysis and further research

The purpose in developing ITDA was to explore the technique as a tool for use in evaluating the effectiveness of different resources available to students. Although there are limitations to this study, the application of the technique in two separate surveys demonstrates its viability. The research can be further developed in the following ways.

Firstly, the technique can be adapted by classroom practitioners. It can be applied narrowly to IT resources or adapted and used for other resources. The questionnaire can be used as a model although, as discussed, an online survey with built in error checking would help to eliminate some errors. There are two elements to the questionnaire, which can all be altered to suit the circumstances: the categorisation of resources and gathering of time-data. If an alternative method of logging time spent in different activities is available (e.g. software that monitors what software the students are using or what task they are performing), this may prove more reliable than a questionnaire. As well as adapting the questionnaire, a practitioner may need to adapt the analysis in the light of further developments in the literature, for instance refinements in the value added methodologies available.

Secondly the research could be extended to cover additional variables. This study did not investigate the relationship between the possession of an IT qualification by a teacher or a factor representing the teacher's experience in using IT. This was omitted from the current analysis because, as discussed in Chapter 2, it was felt that a larger sample size was required in investigating the effects of factors based on teachers rather than students. Other areas which were omitted because their measurement proved too complex for a quantitative analysis included the way in which resources relate to the social interaction necessary for learning. These can be incorporated into future studies by adding a survey of student perceptions of effectiveness. Another factor which was too complex to be included in this survey was the student's socio-economic background. Access to and use of resources has economic implications: lack of access to resources can have an economic cause. It may be that information about students' socio-economic backgrounds may have a bearing on the analysis of the relationship between IT resources and performance. The difficulty with this is finding a suitable proxy for socio-economic background. The questionnaire can be extended to include this information but this is likely to be intrusive and distracting. School effectiveness studies often use eligibility for free school meals as a proxy but this is not appropriate in post-compulsory education.(Martinez, 2001) Where there is another state benefit which reflects the students' socio-economic background, for instance education maintenance allowances (EMAs), this might be used. Alternatively, it is relatively easy for a researcher to get information on a student's postcode from the college's MIS and this can provide some indication of socio-economic background. The UK government publishes indices of deprivation which use a complex range of factors to place local authority wards in socio-economic percentiles, but in a college there may be too little differentiation between the local authority wards in which the students live. Postcodes are also used commercially to indicate the socio-economic placement of households. The value added model used in this study was based on a residual gain analyses which did not incorporate covariates, the covariates being considered separately. In future studies which use this study as a starting point, consideration needs to be made of whether the value added model to be used should incorporate covariates. This may eliminate some of the discussion around research questions 3 to 7; however the incorporation of the covariates into the value added model needs to be explained clearly at the outset.

This study attempted to isolate the relationship between hard work and performance from that of resource use. One of the issues raised was that measuring the time spent in using resources did not assess the quality of time spent in their use. For instance, a student may have spent three hours a week using IT resources at home but the question arises as to how much of their concentration was directed to their work: was the student always on task or flipping between writing an assignment and looking at a social networking website or checking their instant messages? Two areas for development arise from this. The first is the development of time quality variables which can be used in a quantitative analysis and the second is a qualitative follow-up stage to the analysis, as discussed below.

Another issue raised by the analysis is the relationship between the effectiveness of a novelty factor in IT use and performance. If a resource is new, then a student may give it more attention, so that an increase in performance attributable to the resource may fade as use of that resource becomes routine. This was offered as one potential explanation for the differences between the results from 1998 and the results for 2006. A variable accounting for this could be incorporated into the questionnaire stage of the survey by inserting a question rating the users experience in using that resource. It can also be explored in a qualitative analysis.

Studies using ITDA can be extended by using the techniques described here as an initial instrument to get an assessment of the effectiveness of a particular resource, helping to identify whether the resource contributes to effectiveness. It can, therefore, form the first stage in a more detailed later study using qualitative techniques. Treating the use of IT resources as an example, further research can use the techniques explored in this survey to determine whether IT resources contribute to performance and then, once this has been done quantitatively, use qualitative techniques to explore the reasons. For instance interviews with students on how they use IT resources or observations of their use of resources might provide explanations of any association with performance. In this study, such an investigation might have helped to resolve the issue of the relationship between gender on the effectiveness of the use of IT resources. Groups of students who conform to a defined profile might be selected for further study. These profiles might be, defined by the following matrix.

		% IT Use		
		High	Medium	Low
Value Added score	High			
	Medium			
	Low			

A sample of students can be chosen from each of these categories and their use of IT resources studied in greater detail.

If the techniques described here are further tested and developed and prove to be useful, the methods can be encoded, for instance into an evaluative computer package. This can help make improvements in education practice which accrue from effectiveness studies more readily available.

Having commented on the study, the question remains as to what recommendations can be drawn from it.

6.5 Recommendations

Over the last thirty years there has been a dominating need to demonstrate effectiveness in education at all levels, from whole education systems down to practitioners in the classroom. Resource use is an element in effective education, particularly IT resource use which, over the period, developed rapidly. Strategies of effective resource deployment are often devised at higher levels, yet it is educational practitioners who are required to demonstrate effectiveness. There has been a scarcity of methods available to practitioners which fit with the already heavy demands on their time. ITDA identifies relationships between resources use and performance and as such ITDA is proposed as a technique which can be adopted and developed by practitioners as a tool to complement others used to demonstrate effective resource use in self-evaluation as outlined in the literature (e.g. Kyriakides, 2002; Cheung and Cheng , 2002; Meuret and Morlaix, 2003). It is recommended that college ITDA-derived techniques could be used as a component of their self-assessment of effectiveness.

Colleges and other educational institutions have a need to draw up strategic plans for the acquisition, deployment and replacement of resources and these strategies alter over time. Part of the funding for these resources may come out of regular college funds, the supply of which can be budgeted far in advance, but some may come out of specific grants which are made available on a piecemeal basis and which are often directed towards the acquisition of particular resources. In addition to this, the resources available change over time and this is particularly true of IT resources. The need for replacements is greater for IT resources as they must reflect those available in the world outside the institution, as the college aims to be a preparation for the workplace and higher education. Whereas other resources may need replacing because they are worn out, IT resources may need to be replaced because they are obsolete before they wear out.

As part of their strategic plans for acquiring, using and replacing IT resources, colleges need to make an evaluation of the effectiveness of the resources which they already deploy. The recommendation is that ITDA-derived techniques are built into this evaluation, to complement existing methods, such as reference to research and advice from suppliers. This study has also shown the need for a longitudinal aspect in evaluating effectiveness, as a single snapshot may be misleading. As college IT strategies typically may call for a replacement cycle of three years, building ITDA into strategic evaluation allows a rolling three year longitudinal study of effective use, which can be traced against the IT resourcing strategy.

It is also recommended that ITDA techniques be refined and encoded into a software tool which automates the analysis. This tool could either be online or installed locally on college machines. It could also be built in as an addition to the facility management modules which are often part of a college's MIS.

Lastly it is recommended that further research into developing ITDA techniques be carried out, as suggested above.

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APPENDICES

Appendix 1: Survey of colleges' IT use

Appendix 1 Table 1: Survey of proposed college's IT Use

<table>
<tr><th rowspan="2"></th><th colspan="4">College</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td colspan="5">Where IT resources located?</td></tr>
<tr><td>Classroom</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>Library</td><td rowspan="3">Y</td><td rowspan="3">Y</td><td>Y</td><td>Y</td></tr>
<tr><td>Learning resource centre/library</td><td rowspan="3">Y</td><td rowspan="2">Y</td></tr>
<tr><td>Flexible learning centre</td></tr>
<tr><td>IT suite</td><td>Y</td><td>Y</td><td>N</td></tr>
<tr><td>Other</td><td></td><td></td><td>Specialist machines in subject areas (E.g. CAD machines in engineering)</td><td>Specialist machines in subject areas</td></tr>
<tr><td colspan="5">How is IT Used?</td></tr>
<tr><td>IT/computing course</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>Skills development and skills elements on vocational courses</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>Drop-in for students to use applications such as word-processing, spreadsheets etc.</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>Use of CD ROM databases</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>Use of Internet as a research tool</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>Use of computer aided learning packages</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>Use of "video conferencing"</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>Other</td><td>- - -</td><td>- - -</td><td>CAD/CAM</td><td>- - -</td></tr>
<tr><td colspan="5">How is IT integrated into the curriculum</td></tr>
<tr><td>Stand alone PC's in classrooms</td><td>Y</td><td>N</td><td>Y</td><td>N</td></tr>
<tr><td>Networked PC's in classrooms</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>Networked Apple Mac's in classrooms</td><td>N</td><td>N</td><td>Y</td><td>N</td></tr>
<tr><td>Stand alone Apple Mac's in classrooms</td><td>N</td><td>N</td><td>N</td><td>N</td></tr>
<tr><td>Networked PCs in IT suites</td><td>Y</td><td>Y</td><td>Y</td><td>N</td></tr>
<tr><td>Networked Apple Mac's in IT suites</td><td>N</td><td>N</td><td>N</td><td>N</td></tr>
<tr><td>Drop-in/flexible learning facilities?</td><td>Y</td><td>Y</td><td>N</td><td>Y</td></tr>
<tr><td>Lap tops</td><td>Y</td><td>Y</td><td>N</td><td>N</td></tr>
<tr><td>P.C.s connected to projection system</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td></tr>
</table>

	College			
	1	2	3	4
How does the college assess the likely obsolescence of IT equipment before buying it?	N/a	N/a	Equipment is depreciated to 0 in 3 years in accounting terms, but when equipment is bought is carries on being used until the end of its life, even if it is obsolete.	Look at past records
What proportion of software/learning packages are bought in, and what proportion is developed by staff?	At present c. 90% is bought in. This is slowly changing as more staff use ILT.	N/a	All bought in	- All bought in - Possible in House development - Designated IT specialists within each school (i.e. department)
Is there any monitoring of individual software use? Is student use of IT equipment monitored?	- Not much - drop-in centres are monitored	N/a	- drop in centres are monitored (manually or by electronic swipe cards). there is a move towards individual user areas for students on the Network. this is easier to monitor - there is a booking system for the internet	- Manual log in learning center - proposed use of the "Proxy" software for monitoring what students are using on screen. this software can also produce statistics
How is a software package judged to be successful?	- User feedback	N/a	usage	- Microsoft Office - it is an industry standard which everyone uses - other software use is reviewed regularly

	College			
	1	2	3	4
What support are staff given for materials development?	- The cross-college development team have a special room/ equipment - Information and learning technology "champions" are appointed in each curriculum area to enthuse staff into increased usage of IT	N/a	Staff development policy - 2 training rooms - staff development budget - networks (cross-college networks) e.g. curriculum change - People can go on courses outside the college - CLAIT level 1 is compulsory for all staff - Training is both top down and bottom up. Very little IT training is self referred	-The cross-college group gets 1 hour remission of classroom time - Most IT staff development is directed from above (top-down) e.g. there has been a decree that staff should be trained to at least CLAIT level. There are very few requests for IT training from non-IT staff. Most reluctance comes from the IT staff themselves.
What is the proportion of teaching staff to technicians?	N/a		- staff 270, of whom 170 are lecturers. there are 3.5 technicians	Computers to technicians FEDA recommend 70:1 the college has 125:1

Appendix 2: Survey Time Data Questionnaire

Appendix 2a: 1998 Survey Time Data Questionnaire

The following version of the questionnaire was used in the initial survey in 1998.

PhD Research Project Questionnaire.

This questionnaire is being piloted as part of a PhD research project:

The purpose of this questionnaire is to find out how much time you spend using computers to support your learning and how much time you spend in other learning activities.

All responses will be treated in the strictest confidence. Information on individuals will not be shared with the college and the identity of the person to whom the code below refers will not be known to the researcher.

Please enter the code from your student card:	

Please answer all questions

Section 1: About your course

Question 1:		
Have you filled in this questionnaire in any of your other classes?	**Yes** **No** Please circle one answer	*If you have not filled in a questionnaire please complete this now.*

Question 2:

What courses are you on?

If you are studying e.g. a GNVQ plus an A-level, list both of these.

Course 1: ______________________________

Course 2: ______________________________

Course 3: ______________________________

Other Courses:

Course 4: ______________________________

Course 5: ______________________________

Section 2: About your use of time
The aim of this section is to find out how you spend your time at college.

Question 3:	
In an average weekly period, how many hours do you spend on each of the courses you listed in **Question 2**? [Please include the time you spend working at home as well as the time you spend working at college]	
Course	Hours Spent working per week:
1	_______ Hrs
2	_______ Hrs
3	_______ Hrs
4	_______ Hrs
5	_______ Hrs

Question 4:
The aim of this question is to find out how much of the total study time you detailed in Question 3 you spend in computer related activities:

Looking back at the last week, please estimate the time you have spent doing the various **computer-based activities** listed below in the courses you identified in Question 2 (Estimate time to the nearest 10 minutes). Write n/a if the activity is not applicable to you.

Computer based activities

	Word-processing	**Spreadsheets**	**Desk top publishing**	**Information on a CD ROM**	**Information on the Internet**	**E-mail**	**Other (please specify)**
	Time spent in each course	Time spent in each course	Time spent in each course	Time spent in each course	Time spent in each course	Time spent in each course	Time spent in each course
Time spent in class:	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)
Time spent in college outside class (e.g. in the library):	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)
The time you spend outside college (e.g. at home)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)	Course: Time: 1. _____(Hrs/mins) 2. _____(Hrs/mins) 3. _____(Hrs/mins)

Question 5:
The aim of this question is to find out how much of the total study time you identified in Question 3 you spend in non-computer related activities:

Looking back at the last week, please estimate the time you have spent doing the various **non-computer-based activities** listed below in each of the courses you identified in Question 2 (Estimate time to the nearest 10 mins). Write n/a if an activity is not applicable to you

Non-computer based activities:

	direct input from teacher	**Doing group or individual activities**	**Using books, periodicals or other paper-based learning materials**	**Other activity (Please specify)**
	Time spent in each course	Time spent in each course	Time spent in each course	Time spent in each course
Time spent in class:	Course: Time: 1. ______(Hrs/mins) 2. ______(Hrs/mins) 3. ______(Hrs/mins)	Course: Time: 1. ______(Hrs/mins) 2. ______(Hrs/mins) 3. ______(Hrs/mins)	Course: Time: 1. ______(Hrs/mins) 2. ______(Hrs/mins) 3. ______(Hrs/mins)	Course: Time: 1. ______(Hrs/mins) 2. ______(Hrs/mins) 3. ______(Hrs/mins)
The Time you spend in college outside class (e.g. in the library)		Course: Time: 1. ______(Hrs/mins) 2. ______(Hrs/mins) 3. ______(Hrs/mins)	Course: Time: 1. ______(Hrs/mins) 2. ______(Hrs/mins) 3. ______(Hrs/mins)	Course: Time: 1. ______(Hrs/mins) 2. ______(Hrs/mins) 3. ______(Hrs/mins)
The time you spend outside college (e.g. at home)		Course: Time: 1. ______(Hrs/mins) 2. ______(Hrs/mins) 3. ______(Hrs/mins)	Course: Time: 1. ______(Hrs/mins) 2. ______(Hrs/mins) 3. ______(Hrs/mins)	Course: Time: 1. ______(Hrs/mins) 2. ______(Hrs/mins) 3. ______(Hrs/mins)

Section 3: About the access you have to IT equipment
The aim of this section is to find out whether you have access to computers outside college and where.

Question 6:	
Do you have access to a computer outside college? Please tick from of the following:	
No access	❑ Are you likely to have access in the future (e.g. purchase of a PC) ________________
At home – shared use	❑ Whose computer do you use? ____
At home - sole use	❑
Computers in a public library	❑
Computers in an “Internet Café”	❑
Other (please specify)	❑ Details ____ ____ ____ ____ ____

Section 4 About this questionnaire [Only on Pilot]:
The purpose of running the questionnaire today is to check whether people find it easy to use. To help me please could you answer the questions below:
1. Clarity: a) Did you understand the question?
Rate your understanding on the following scale: (circle one number on the scale): **1** **2** **3** **4** **5** No Understanding ← → Complete Understanding
✐Write further details here if you want to:
b) Did you understand where to put your answer?
Rate your understanding on the following scale: (circle one number on the scale): **1** **2** **3** **4** **5** No Understanding ← → Complete Understanding
✐Write further details here if you want to:
2. Ambiguity Did you feel that any of the questions were ambiguous, i.e. that you could have given several answers which would fit?
Did you feel that any of the questions were ambiguous, i.e. that you could have given several answers which would fit? Rate ambiguity on the following scale: (circle one number on the scale) **1** **2** **3** **4** **5** No Ambiguity← → Very Ambiguous
✐Write further details here if you want to:
3. Coverage: Did you feel that the questions covered the activities with which you spend your time in college work, or do you think other categories should be added?
Rate coverage on the following scale: (circle one number on the scale): **1** **2** **3** **4** **5** Inadequate coverage← → Adequate coverage
✐Write further details here if you want to:
4. Ease of use Did you feel that the questionnaire was easy to use?
Rate ease of use on the following scale: (circle one number on the scale): **1** **2** **3** **4** **5** Easy to use← → Hard to use

✐Write further details here if you want to:
5. Aims Do you feel you understand the aim of the questionnaire?
Rate understanding on the following scale: (circle one number on the scale): **1** **2** **3** **4** **5** Did not understand ← → Understood
✐Write further details here if you want to:
6. General Comments
✐Please write any further comments you have here:

Appendix 2b: 2006 Survey Time Data Questionnaire

For the 2006 survey the questionnaire was revised with the intention of making it easier to use. This process was constrained by the need to ask the same questions in order to gather the same data as in 1998. The main amendments involved pre-populating the form with data about the student's course from the college's MIS, using mail merge technology.

UNIVERSITY OF BIRMINGHAM

PHD RESEARCH PROJECT QUESTIONNAIRE.

The purpose of this questionnaire is to find out how much time you spend using computers to support your learning and how much time you spend in other learning activities. It is being used as part of a PhD research project at the University of Birmingham.

All responses will be treated in the strictest confidence. Information on individuals will not be shared with the college and the identity of the person to whom the code below refers will not be known to the researcher.

Please enter the ID Number from your student card:	[pre-printed]

Please answer all questions

Section 1: About your courses

Please answer questions of the following courses:

Course 1: [pre-printed course]

Course 2: [pre-printed course]

Course 3: [pre-printed course]

Section 2: About your use of time

The aim of this section is to find out how you spend your time at college.

Question 1:

What is the total weekly amount of time you spend, on average, on each of the courses listed in section 1?

Please include the time you spend working at home as well as the time you spend working at college. Include class time, time spent working in college outside class, time spent working outside college (e.g. homework)

Course	Hours Spent working per week:		
Course 1	Class time in college ________ Hrs	Studying at college but outside class ________ Hrs	Studying outside college ________ Hrs
Course 2	Class time in college ________ Hrs	Studying at college but outside class ________ Hrs	Studying outside college ________ Hrs
Course 3	Class time in college ________ Hrs	Studying at college but outside class ________ Hrs	Studying outside college ________ Hrs

Question 2: Computer based activities

The aim of this question is to find out how much of the total study time you detailed in Question 1 you spend using IT resources.

Looking back at the last week, please estimate the time you have spent doing the various **computer-based activities** listed below in each of your courses (detailed in section 1). Include *only* activity related to your studies. Please estimate the time to the nearest 10 minutes. Write n/a if the activity is not applicable to you.

	Word-processing		Using spreadsheets		Using desk top publishing		Finding information on a CD ROM		Finding information on the Internet		Using E-mail (study related only)		Other activity (please specify)	
	Time spent for each course in hours and minutes													
Time spent in class:		Time		Time		Time		Time		Time		Time		Time
	Course 1.		Course 1.		Course 1.		Course 1.		Course 1.		Course 1.		Course 1.	
	Course 2.		Course 2.		Course 2.		Course 2.		Course 2.		Course 2.		Course 2.	
	Course 3.		Course 3.		Course 3.		Course 3.		Course 3.		Course 3.		Course 3.	
Time spent in college outside class (e.g. in the library):		Time		Time		Time		Time		Time		Time		Time
	Course 1.		Course 1.		Course 1.		Course 1.		Course 1.		Course 1.		Course 1.	
	Course 2.		Course 2.		Course 2.		Course 2.		Course 2.		Course 2.		Course 2.	
	Course 3.		Course 3.		Course 3.		Course 3.		Course 3.		Course 3.		Course 3.	
Time spent outside college (e.g. at home)		Time		Time		Time		Time		Time		Time		Time
	Course 1.		Course 1.		Course 1.		Course 1.		Course 1.		Course 1.		Course 1.	
	Course 2.		Course 2.		Course 2.		Course 2.		Course 2.		Course 2.		Course 2.	
	Course 3.		Course 3.		Course 3.		Course 3.		Course 3.		Course 3.		Course 3.	

Question 3: Non-computer based activities

The aim of this question is to find out how much of the total study time you identified in Question 1 you spend in non-computer related activities.

Looking back at the last week, please estimate the time you have spent doing the various **non-computer based activities** listed below in each of your courses (detailed in section 1). Please estimate the time to the nearest 10 minutes. Write n/a if the activity is not applicable to you.

	Direct input from teacher		Doing group or individual activities		Using books, periodicals or other paper-based learning materials		Other activity (Please specify)	
	Time spent for each course in hours and minutes							
Time spent in class:		Time		Time		Time		Time
	Course 1.		Course 1.		Course 1.		Course 1.	
	Course 2.		Course 2.		Course 2.		Course 2.	
	Course 3.		Course 3.		Course 3.		Course 3.	
Time spent in college outside class (e.g. in the library):		Time		Time		Time		Time
	Course 1.		Course 1.		Course 1.		Course 1.	
	Course 2.		Course 2.		Course 2.		Course 2.	
	Course 3.		Course 3.		Course 3.		Course 3.	
The time you spend outside college (e.g. at home)		Time		Time		Time		Time
	Course 1.		Course 1.		Course 1.		Course 1.	
	Course 2.		Course 2.		Course 2.		Course 2.	
	Course 3.		Course 3.		Course 3.		Course 3.	

Section 3: About the access you have to IT equipment
The aim of this section is to find about the access you have to computers outside college

Question 4:		
Do you have access to and use a computer outside college? Please tick one of the following:		
No access	❑	
At home – shared use	❑	
At home - sole use	❑	
Computers in a public library	❑	
Computers in an "Internet Café"	❑	
Other (please specify)	❑	*Details:* ____________ ____________ ____________ ____________

Thank you very much. Please hand the completed questionnaire to the researcher or your class teacher.

Appendix 2c: 2006 survey time data questionnaire notes for teachers

In 1998 the researcher was present when the questionnaires were being filled in by the students, and was able to deal with their queries. In 2006 the following instructions were given to teacher instead of the researcher being present.

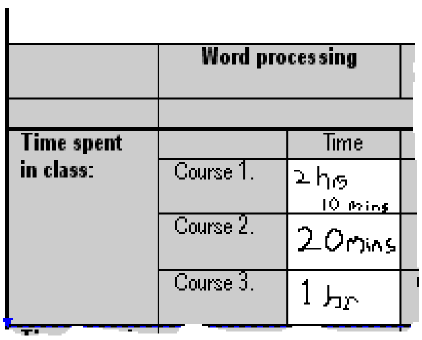
UNIVERSITY OF BIRMINGHAM
PHD RESEARCH PROJECT QUESTIONNAIRE.
ADMINISTRATION NOTES

The purpose of this questionnaire is to find out how much time students spend using computers to support their learning and how much time they spend in other learning activities. It is being used as part of a PhD research project at the University of Birmingham.

Please could you get your tutor group to complete these questionnaires, using the following guidelines.

1) As the student's name and college ID number are pre-printed on the front cover of the questionnaire, please ask them to check they are using the correct sheet.
2) The main courses being studied have been listed on page 2 of the questionnaire. When answering the questions, they should answer only with reference to these courses. If they are no longer studying the course listed, ask them to cross it out.
3) In question 1, they should write the total amount of time spent on each of the courses:
    a. In class time at college
    b. At any other time at college (e.g. in the library)
    c. Outside college (e.g. at home)

4) In question 2 (computer based activities) they should write the amount of time spent on each of the courses in the categories listed. For example, for word-processing activities in class:



		Word processing
Time spent in class:		Time
	Course 1.	2 hrs 10 mins
	Course 2.	20mins
	Course 3.	1 hr

5) In question 3 (non-computer based activities); they should write the amount of time spent for each of the courses in the categories listed.
6) In question 4 please tick the boxes which indicate access to a computer outside college. More than one box can be ticked. If they have access to a computer somewhere that has not been listed (e.g. at work), the "other" box should be ticked and where you have this access should be entered.

The completed questionnaire should be returned to the tutor.

Appendix 3: Descriptive statistics

Appendix 3a: National statistics – subjects studied by gender

Appendix 3 Table 1: National statistics - subject areas studied by gender (2002 – 2003)

Area of learning	**Male (thousands)**		**Female (thousands)**		**Total**	**Total as %**
Information & communications technology	285.2	40%	434.8	60%	720.0	18%
Health, social care and public services	197.1	34%	375.6	66%	572.7	15%
Not known	232.2	42%	315.8	58%	548.0	14%
Business administration, management & professional	111.0	32%	235.9	68%	346.9	9%
Foundation programmes	156.0	44%	198.7	56%	354.7	9%
Hospitality, sports, leisure and travel	94.5	37%	161.4	63%	255.9	7%
Visual and performing arts and media	67.6	34%	133.0	66%	200.6	5%
English, languages and communications	69.1	38%	111.6	62%	180.7	5%
Hairdressing and beauty therapy	17.4	15%	100.2	85%	117.6	3%
Humanities	44.7	33%	92.7	67%	137.4	4%
Science and mathematics	54.3	43%	72.6	57%	126.9	3%
Retailing, customer service and transportation	26.4	40%	40.4	60%	66.8	2%
Land-based provision	21.3	43%	27.7	57%	49.0	1%
Engineering, technology and manufacturing	96.0	86%	15.2	14%	111.2	3%
Construction	110.7	94%	6.9	6%	117.6	3%
Total	1,583.5		2,322.5		3,906.0	
Source DFES - Statistics (http://www.dfes.gov.uk/) – I have added the percentage columns						

Appendix 3 Table 2: National statistics - subject areas studied by gender (2005 – 2006)

Area of learning	**Male (thousands)**		**Female (thousands)**		**Total**	
Agriculture, horticulture and animal care	24.7	2%	28.9	1%	53.6	1%
Arts, media and publishing	89.9	6%	166.4	8%	256.3	7%
Business, administration and law	84.1	6%	129.4	6%	213.5	6%
Construction	101.9	7%	6.6	0%	108.5	3%
Education and training	20.4	1%	64.3	3%	84.8	2%
Engineering and manufacturing technologies	126.1	9%	29.3	1%	155.4	4%
Health, public services and care	191.2	13%	455.4	21%	646.6	18%
History, philosophy and theology	14.8	1%	26.4	1%	41.2	1%
Information & communication technology	222.0	15%	317.1	15%	539.0	15%
Languages, literature and culture	69.8	5%	131.0	6%	200.8	6%
Leisure, travel and tourism	69.0	5%	52.7	2%	121.7	3%
Preparation for life and work	344.3	24%	455.7	21%	800.0	22%
Retail and commercial enterprise	45.4	3%	144.6	7%	190.0	5%
Science and mathematics	37.3	3%	59.2	3%	96.6	3%
Social sciences	9.9	1%	17.3	1%	27.2	1%
Unknown	40.3	3%	53.2	2%	93.5	3%
Total	**1,450.7**		**2,137.7**		**3,628.7**	

Appendix 3b: Time Spent in different activities

Appendix 3 Table 3: Time data – time spent in different activities by gender

			Statistic											
			IT activities						Non-IT activities					
			In college in class		In college outside class		Outside college		In college in class		In college outside class		Outside college	
Category		Total %	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
All 1998		100%	79		104		101		202		148		163	
All 2006		100%	173		229		228		284		226		239	
Gender	Male 1998	35	33	42	34	33	38	38	72	36	52	35	61	37
	Male 2006	41	68	39	89	39	90	39	119	42	92	41	103	43
	Female 1998	53	46	58	61	59	58	58	107	53	79	53	82	50
	Female 2006	58	105	61	140	61	138	61	165	58	134	58	136	57
	No info 1998	12	0	0	9	9	5	5	23	11	17	12	20	12
	No info 2006	0	0	0	0	0	0	0	0	0	0	0	0	0

NOTE:
1) The **Total %**: the percentage of that gender for all student-subjects in this category, for comparison purposes
2) ***"n":*** the number who report a figure for this activity which is not zero. The **%** column is his figure as a percentage for easier comparison.

Appendix 3 Table 4: Time data – time spent in different activities by ethnicity

			IT activities						Non-IT activities					
			In college in class		In college outside class		Outside college		In college in class		In college outside class		Outside college	
Category		Total %	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
All 1998		100	79		104		101		202		148		163	
All 2006		100	173		229		228		284		226		239	
Ethnicity	Asian 1998	67	68	86	74	71	78	77	136	67	106	72	108	66
	Asian 2006	80	135	78	176	77	180	79	229	81	182	81	186	78
	Black 1998	14	11	14	16	15	15	15	30	15	19	13	24	15
	Black 2006	10	20	12	28	12	25	11	27	10	23	10	32	13
	White 1998	6	0	0	5	5	3	3	13	6	6	4	11	7
	White 2006	4	10	6	12	5	11	5	12	4	9	4	9	4
	No info 1998	12	0	0	9	9	5	5	23	11	17	12	20	12
	No info 2006	6	8	5	13	6	12	5	16	6	12	5	12	5

NOTE:
1) The following amalgamations have been made to the ethnic categories, because of the small population of certain categories:
2) "Asian" above includes the categories Bangladeshi, Indian, Pakistani and Other Asian
3) "Black" includes Black African, Black Caribbean & Black other
4) Ethnic categories where there were no students (e.g. "Chinese", "other") have been omitted
3) The **Total %**: the percentage of that gender for all student-subjects in this category, for comparison purposes
5) ***"n":*** signifies the number who report a figure for this activity which is not zero

Appendix 3 Table 5: Time data – time spent in different activities by age

			IT activities						Non-IT activities					
			In college in class		In college outside class		Outside college		In college in class		In college outside class		Outside college	
Category		Total %	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
All 1998		100	79		104		101		202		148		163	
All 2006		100	173		229		228		284		226		239	
Age	16 (1998)	61	56	71	65	63	64	64	123	61	89	60	103	63
	16 (2006)	1	1	1	2	1	1	1	3	1	3	1	3	1
	17 (1998)	16	15	19	19	18	20	20	33	16	27	18	27	17
	17 (2006)	63	98	57	122	53	120	53	187	66	145	64	157	66
	18 (1998)	1	4	5	7	7	8	8	17	8	12	8	9	5
	18 (2006)	27	35	20	37	16	46	20	69	24	57	25	57	24
	19 + (1998)	0.3	3	4	3	3	3	3	6	3	3	2	4	3
	19+ (2006)	9	4	2	16	7	14	6	25	9	21	9	22	9
	No info 1998	12	9	11	9	9	5	5	23	11	28	19	20	12
	No info 2006	0	0	0	0	0	0	0	0	0	0	0	0	0

NOTE:
1) The **Total %**: the percentage of that gender for all student-subjects in this category, for comparison purposes
2) **"*n*":** the number who report a figure for this activity which is not zero. The **%** column is his figure as a percentage for easier comparison

Appendix 3 Table 6: Time data– time spent in activities by access to IT resources outside college

					IT activities			Non-IT activities		
					In college in class	In college outside class	Outside college	In college in class	In college outside class	Outside college
Access to IT resources				Total %	%	%	%	%	%	%
Some use reported outside college	At Home	Sole Use	1998	18	22	21	26	20	19	22
			2006	18	20	19	20	18	18	19
		Shared use	1998	55	57	53	64	55	55	55
			2006	70	71	72	71	73	75	72
	Elsewhere	Public Library	1998	22	33	24	24	22	19	20
			2006	17	19	19	20	13	19	19
		Internet Café	1998	4	3	3	3	4	1	4
			2006	2	12	10	10	10	10	11
		Other	1998	6	6	6	4	6	4	4
			2006	2	3	3	3	2	2	3
No access outside college			1998	16	11	19	7	18	23	20
			2006	3	1	1	2	1	1	2
No Data			1998	0.4	0	0	0	0	0	0
			2006	0	0	0	0	0	0	0

Appendix 4: Appendices for Chapter 5 (statistical analysis)

Appendix 4a: UCAS POINTS Scale

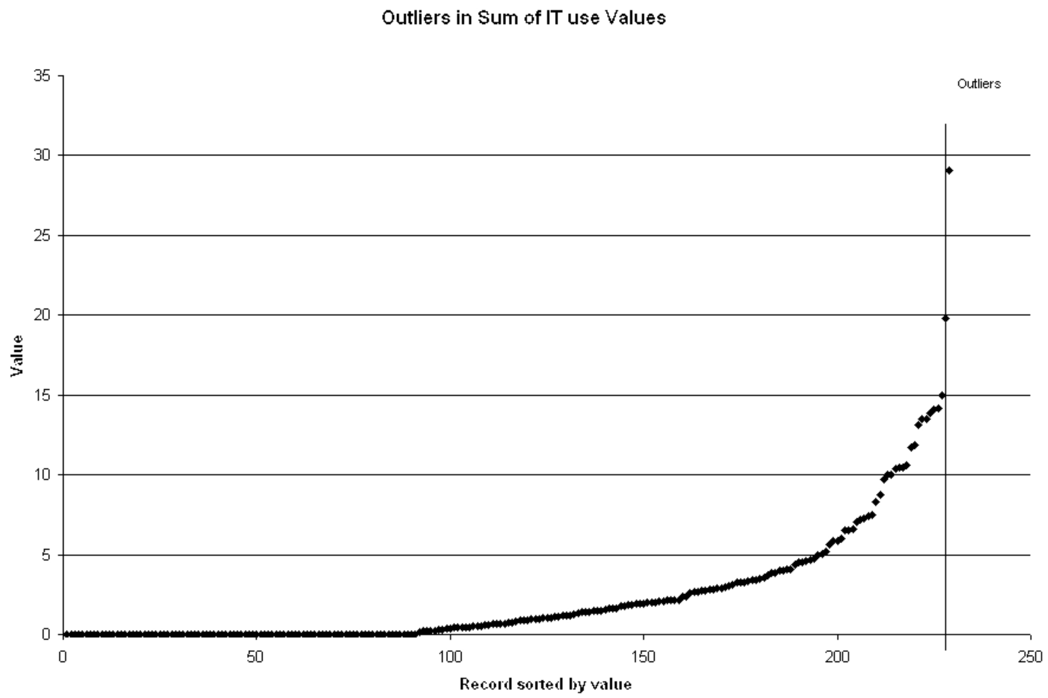
The points scales used in this study is as follows:

Grade	Points
A	10
B	8
C	6
D	4
E	2
U	0
X	0

Appendix 4b: Outliers in time data statistics

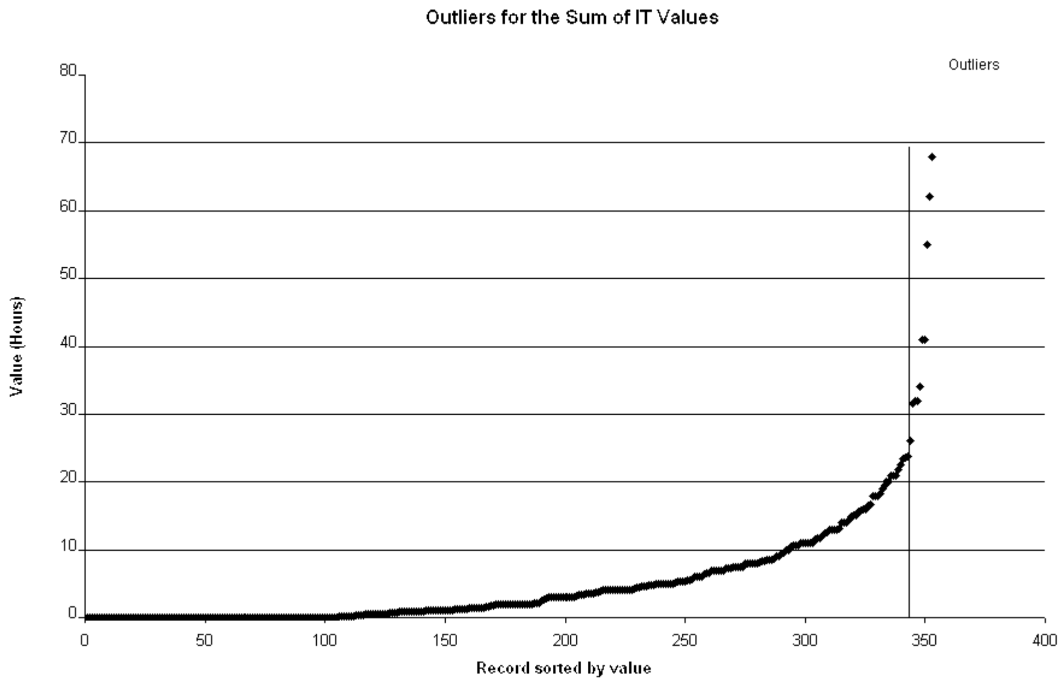
The following scatter graphs show the outlying values in the range of the time data for computer use – divided into the sum of all IT based activities and the sum of all non-IT based activities:

Appendix 4b Figure 1: 1998 Data collection: sum of IT based activities



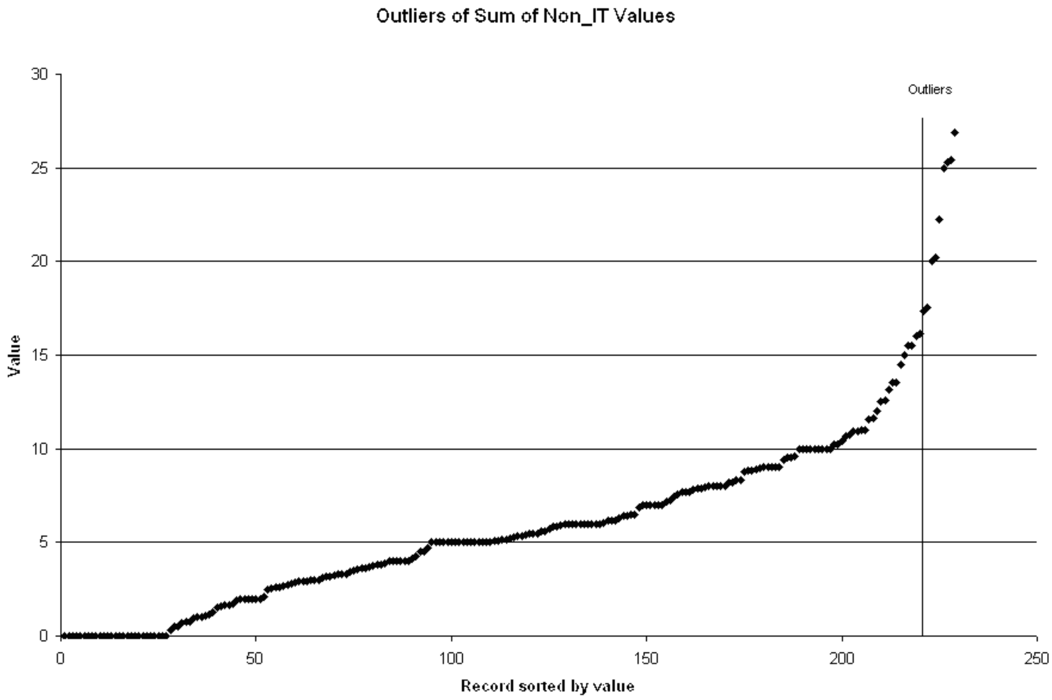
2 values have been excluded here as lying outside the trend line.

Appendix 4b Figure 2: 2006 Data collection: sum of IT based activities



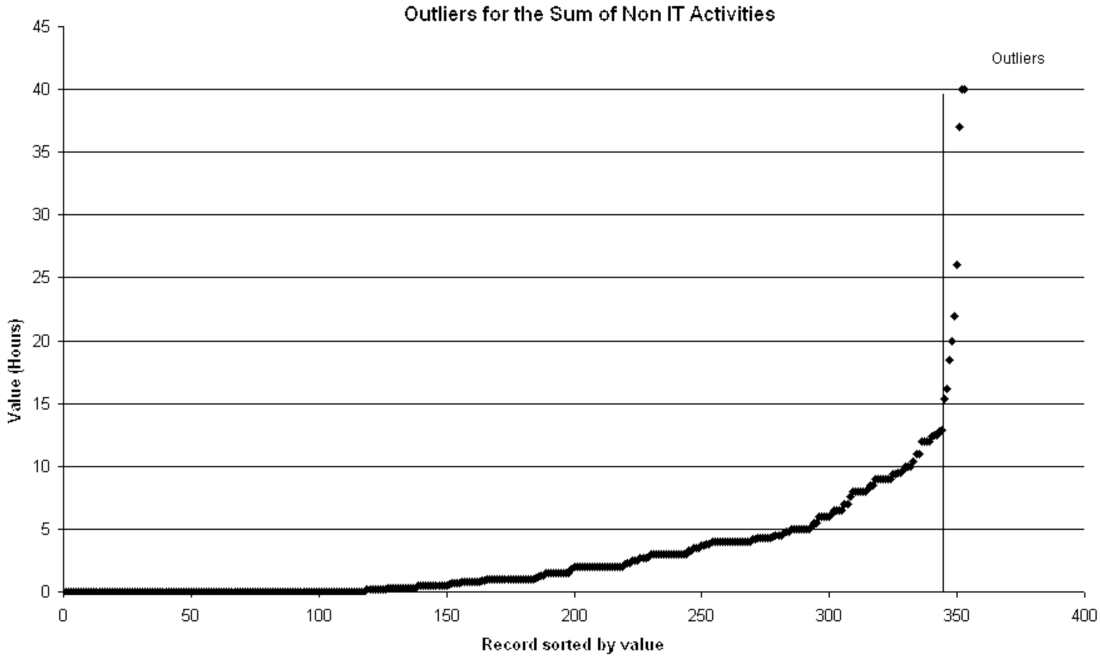
10 values have been excluded here as lying outside the trend line.

Appendix 4b Figure 3: 1998: Sum of non-IT based activities



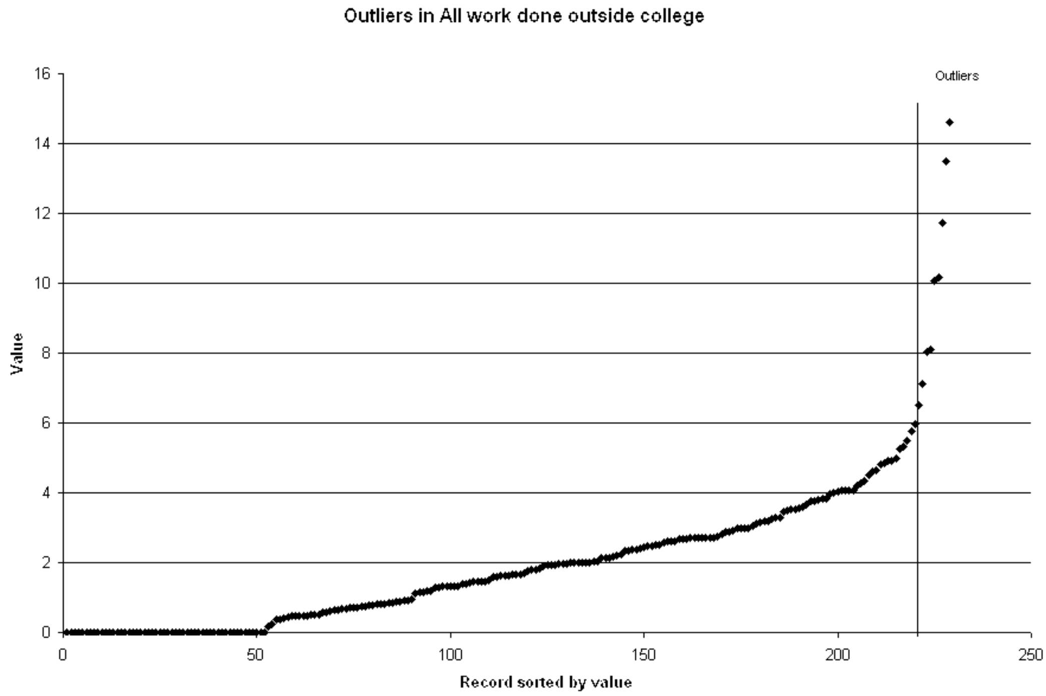
9 values have been excluded here as lying outside the trend line.

Appendix 4b Figure 4: 2006: Sum of non-IT based activities



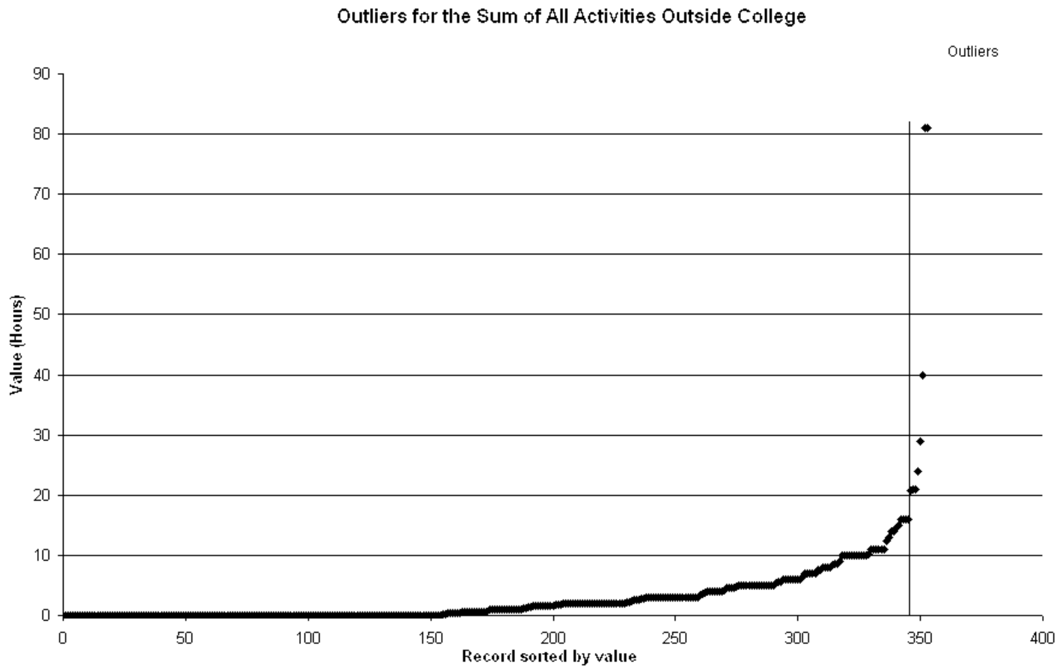
9 values have been excluded here as lying outside the trend line.

Appendix 4b Figure 5: 1998 All IT activities outside college



12 values have been excluded here as lying outside the trend line.

Appendix 4b Figure 6: 2008 All IT activities outside college



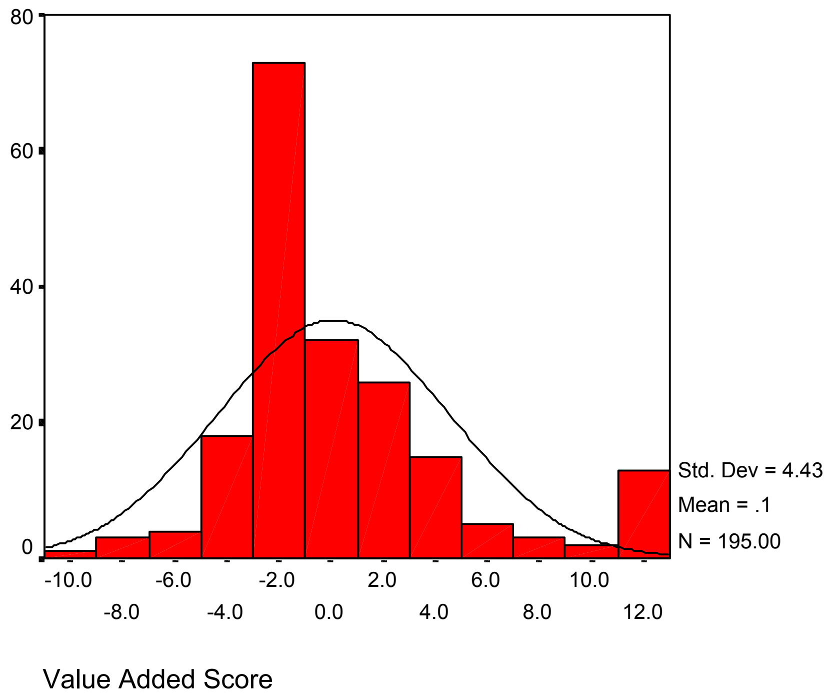
8 values have been excluded here as lying outside the trend line.

Appendix 4c: Histogram analysis of the variables

A better idea of the variables and their attributes can be seen with a histogram of the distribution of values for each of them:

Value added Score

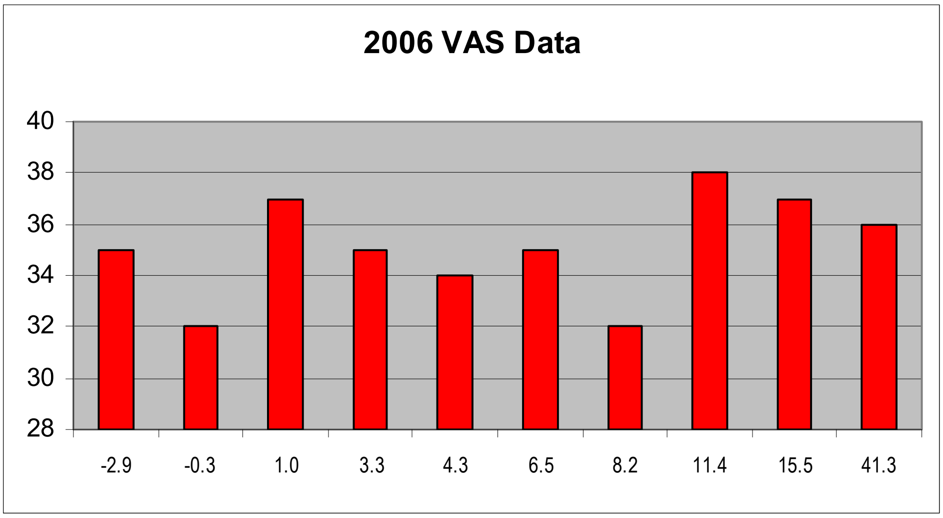
Appendix 4c Figure 1: 1998 Distribution of value added score (Residual UCAS points)



There is an obvious peak in the distribution at a value added score of -2.0. Looking at the breakdown of the records giving a value added score of –2.0 reveals no obvious pattern which might explain the same score. There is a degree of fluctuation from the spread across categories of the whole sample. This is to be expected when the sample sized is reduced like this. The only difference of note is that there is a much greater proportion of students studying in courses in the science faculty who got a value added score of –2.0 than in the whole sample.

The distribution in the 2006 survey showed no clear pattern, as shown in the figure below.

Appendix 4d Figure 2: 2006 Distribution of value added score (Residual UCAS points)



Appendix 4d: Correlation tables

Time data

Appendix 4d Table 1: 1998 Time data - Spearman correlations

Correlations - Spearman

	Category of IT use 1	Category of IT use 2	Category of IT use 3	Category of IT use 4	Category of non-It use 1	Category of non-It use 2	Category of non-It use 3	Category of non-It use 4	Work outside college category 1	Work outside college category 2	Work outside college category 3	Work outside college category 4
Value added score	**-0.26****	-0.12	-0.03	**0.40****	-0.06	-0.03	-0.12	**0.21****	-0.01	**-0.21****	-0.12	**0.35****
Correlation coefficient Sig. (2-tailed)	0.00	0.09	0.67	0.00	0.43	0.67	0.09	0.00	0.91	0.00	0.09	0.00

Notes
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
N/a denotes those categories which are empty

Appendix 4d Table 2: 2006 Time data - Spearman correlations

Correlations - Spearman

	Category of IT use 1	Category of IT use 2	Category of IT use 3	Category of IT use 4	Category of non-It use 1	Category of non-It use 2	Category of non-It use 3	Category of non-It use 4	Work outside college category 1	Work outside college category 2	Work outside college category 3	Work outside college category 4
Value added score	0.09	0.00	-0.10	0.00	0.09	-0.01	-0.03	-0.05	0.07	0.03	0.00	**-0.11***
Correlation Coefficient Sig. (2-tailed)	0.10	0.95	0.07	0.98	0.11	0.83	0.53	0.36	0.18	0.61	0.94	0.05

Notes
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
N/a denotes those categories which are empty Correlation is significant at the 0.05 level (2-tailed).

Course data

Appendix 4d Table 3: 1998 Course data - Spearman correlations

Correlations - Spearman	Faculty category 1 (dummy)	Faculty category 2 (dummy)	Faculty category 3 (dummy)	Faculty category 4 (dummy)	Faculty category 5 (dummy)	Faculty category 6 (dummy)	Faculty category 7 (dummy)	Faculty category 8 (dummy)	Faculty category 9 (dummy)	Faculty category 10 (dummy)
Value added score Correlation coefficient	0.06	**0.31***	**-0.22***	-0.04	0.04	**-0.2***	0.06	0.10	**-0.15***	0.13
Sig. (2-tailed)	0.42	0.00	0.00	0.54	0.58	0.01	0.41	0.17	0.04	0.06

Notes

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
N/a denotes those categories which are empty

Appendix 4d Table 4: 2006 Course data – Spearman correlations

Correlations – Spearman	Faculty category 1 (dummy)	Faculty category 2 (dummy)	Faculty category 3 (dummy)	Faculty category 4 (dummy)	Faculty category 5 (dummy)	Faculty category 6 (dummy)	Faculty category 7 (dummy)	Faculty category 8 (dummy)	Faculty category 9 (dummy)	Faculty category 10 (dummy)
Value added score Correlation coefficient	-0.05	0.01	0.09	**0.17****	0.00	**-0.11***	0.09	-0.04	**-0.18****	N/a
Sig. (2-tailed)	0.35	0.83	0.08	0.00	0.97	0.05	0.08	0.47	0.00	N/a

Notes

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
N/a denotes those categories which are empty

Student data

Appendix 4d Table 5: 1998 Student data - Spearman correlations

Correlations - Spearman	IT Input (dummy)	Age at survey	Gender dummy (M=1, F=0)
Value added score Correlation coefficient	**-0.38***	**0.31***	-0.08
Sig. (2-tailed)	0.01	0.00	0.25

Notes

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
N/a denotes those categories which are empty

Appendix 4d Table 6: 2006 Student data - Spearman correlations

Correlations - Spearman	IT Input (dummy)	Age at Survey	Gender dummy (M=1, F=0)
Value added score Correlation coefficient	**-0.16****	**0.13***	-0.04
Sig. (2-tailed)	0.00	0.02	0.43

Notes

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
N/a denotes those categories which are empty

Appendix 4e: ANOVA data output from SPSS

ANOVA: Value added Score/ course categories

Appendix 4e Table 1: 1998 Descriptives

Faculty category	N	Mean VAS	Std. deviation	Std. error	95% confidence interval for mean		Minimum	Maximum
					Lower bound	Lower bound		
1 Art & design	7	**0.38**	2.521	0.953	-1.95	2.71	-3	4
2 Business studies	34	**4.21**	5.786	0.992	2.19	6.23	-3	12
3 English	31	**-2.15**	2.982	0.536	-3.25	-1.06	-8	4
4 Humanities and social studies	34	**-0.62**	3.365	0.577	-1.79	0.56	-8	10
5 IT	20	**0.70**	4.635	1.036	-1.47	2.87	-4	12
6 Maths	16	**-2.19**	4.473	1.118	-4.57	0.19	-10	11
7 Other languages	4	**2.41**	6.619	3.310	-8.12	12.94	-2	12
8 Performance arts	11	**0.36**	2.111	0.636	-1.05	1.78	-4	2
9 Science	28	**-1.62**	2.223	0.420	-2.48	-0.76	-6	4
10 General studies	10	**1.25**	2.212	0.700	-0.33	2.84	-2	4
Total	195	**0.09**	4.428	0.317	-0.53	0.72	-10	12

Appendix 4e Table 2: 2006 Descriptives

	N	Mean VAS	Std. deviation	Std. error	95% confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
1 Art & design	23	**3.57**	7.519	1.568	0.31	6.82	-11	17
2 Business studies	28	**5.86**	8.418	1.591	2.59	9.12	-7	24
3 English	54	**6.98**	6.537	0.890	5.20	8.77	-7	22
4 Humanities and social studies	93	**7.46**	6.937	0.719	6.03	8.89	-7	24
5 IT	11	**5.00**	6.648	2.005	0.53	9.47	-5	17
6 Maths	35	**3.71**	9.186	1.553	0.56	6.87	-13	41
7 Other languages	10	**9.60**	7.058	2.232	4.55	14.65	3	20
8 Performance arts	12	**4.50**	6.895	1.991	0.12	8.88	-1	24
9 Science	85	**3.42**	8.446	0.916	1.60	5.25	-13	41
Total	351	**5.54**	7.810	0.417	4.72	6.36	-13	41

Appendix 4e Table 3: 1998 test of homogeneity of variances - value added score

Levene statistic	df1	df2	Sig.
5.984	9	185	**0.000**

Appendix 4e Table 4: 2006 test of homogeneity of variances - value added score

Levene statistic	df1	df2	Sig.
0.375	8	342	0.933

Appendix 4e Table 5: 1998 ANOVA

	Sum of squares	df	Mean square	F	Sig.
Between groups	958.860	9	106.540	6.928	**0.000**
Within groups	2844.840	185	15.378		
Total	3803.700	194			

Appendix 4e Table 6: 2006 ANOVA

	Sum of squares	df	Mean square	F	Sig.
Between groups	1,226.829	8	153.354	2.606	0.009
Within groups	20,124.476	342	58.843		
Total	21,351.305	350			

Appendix 4e Table 7: 1998 multiple comparisons - dependent variable: value added score

Test: Tukey HSD

(I) Faculty category	(J) Faculty category	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
1	**2**	-3.83	1.628	0.360	-9.04	1.38
	3	2.53	1.641	0.873	-2.73	7.79
	4	1.00	1.628	1.000	-4.22	6.21
	5	-0.32	1.722	1.000	-5.83	5.20
	6	2.57	1.777	0.911	-3.12	8.26
	7	-2.03	2.458	0.998	-9.91	5.84
	8	0.01	1.896	1.000	-6.06	6.09
	9	2.00	1.657	0.970	-3.31	7.31
	10	-0.87	1.932	1.000	-7.06	5.31
2	**1**	3.83	1.628	0.360	-1.38	9.04
	3	**6.36***	0.974	0.000	3.24	9.48
	4	**4.83***	0.951	0.000	1.78	7.87
	5	3.51	1.105	0.054	-0.03	7.05
	6	**6.40***	1.189	0.000	2.59	10.21
	7	1.80	2.073	0.997	-4.84	8.44
	8	3.85	1.360	0.135	-.51	8.20
	9	**5.83***	1.001	0.000	2.63	9.04
	10	2.96	1.411	0.533	-1.56	7.47
3	**1**	-2.53	1.641	0.873	-7.79	2.73
	2	**-6.36***	0.974	0.000	-9.48	-3.24
	4	-1.53	0.974	0.858	-4.65	1.58
	5	-2.85	1.125	0.258	-6.45	.75
	6	0.04	1.207	1.000	-3.83	3.91
	7	-4.56	2.083	0.467	-11.24	2.11
	8	-2.52	1.376	0.717	-6.92	1.89
	9	-0.53	1.022	1.000	-3.80	2.74
	10	-3.40	1.426	0.340	-7.97	1.16
4	**1**	-1.00	1.628	1.000	-6.21	4.22
	2	**-4.83***	.951	0.000	-7.87	-1.78
	3	1.53	.974	0.858	-1.58	4.65
	5	-1.31	1.105	0.973	-4.85	2.22
	6	1.57	1.189	0.947	-2.23	5.38
	7	-3.03	2.073	0.905	-9.67	3.61
	8	-0.98	1.360	0.999	-5.34	3.38
	9	1.00	1.001	0.992	-2.20	4.21
	10	-1.87	1.411	0.946	-6.39	2.65
5	**1**	0.32	1.722	1.000	-5.20	5.83
	2	-3.51	1.105	0.054	-7.05	0.03
	3	2.85	1.125	0.258	-.75	6.45
	4	1.31	1.105	0.973	-2.22	4.85
	6	2.89	1.315	0.463	-1.32	7.10
	7	-1.71	2.148	0.999	-8.59	5.16
	8	0.33	1.472	1.000	-4.38	5.05
	9	2.32	1.148	0.586	-1.36	6.00
	10	-0.56	1.519	1.000	-5.42	4.31
6	**1**	-2.57	1.777	0.911	-8.26	3.12
	2	**-6.40***	1.189	0.000	-10.21	-2.59
	3	-0.04	1.207	1.000	-3.91	3.83
	4	-1.57	1.189	0.947	-5.38	2.23
	5	-2.89	1.315	0.463	-7.10	1.32
	7	-4.60	2.192	0.530	-11.62	2.42
	8	-2.55	1.536	0.814	-7.47	2.36
	9	-0.57	1.229	1.000	-4.51	3.37
	10	-3.44	1.581	0.475	-8.51	1.62

[1998 multiple comparisons table continued …]

(I) Faculty category	(J) Faculty category	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
7	**1**	2.03	2.458	0.998	-5.84	9.91
	2	-1.80	2.073	0.997	-8.44	4.84
	3	4.56	2.083	0.467	-2.11	11.24
	4	3.03	2.073	0.905	-3.61	9.67
	5	1.71	2.148	0.999	-5.16	8.59
	6	4.60	2.192	0.530	-2.42	11.62
	8	2.05	2.290	0.996	-5.29	9.38
	9	4.03	2.096	0.653	-2.68	10.75
	10	1.16	2.320	1.000	-6.27	8.59
8	**1**	-0.01	1.896	1.000	-6.09	6.06
	2	-3.85	1.360	0.135	-8.20	0.51
	3	2.52	1.376	0.717	-1.89	6.92
	4	0.98	1.360	0.999	-3.38	5.34
	5	-0.33	1.472	1.000	-5.05	4.38
	6	2.55	1.536	0.814	-2.36	7.47
	7	-2.05	2.290	0.996	-9.38	5.29
	9	1.99	1.395	0.919	-2.48	6.45
	10	-0.89	1.713	1.000	-6.38	4.60
9	**1**	-2.00	1.657	0.970	-7.31	3.31
	2	**-5.83***	1.001	0.000	-9.04	-2.63
	3	0.53	1.022	1.000	-2.74	3.80
	4	-1.00	1.001	0.992	-4.21	2.20
	5	-2.32	1.148	0.586	-6.00	1.36
	6	0.57	1.229	1.000	-3.37	4.51
	7	-4.03	2.096	0.653	-10.75	2.68
	8	-1.99	1.395	0.919	-6.45	2.48
	10	-2.87	1.445	0.607	-7.50	1.75
10	**1**	0.87	1.932	1.000	-5.31	7.06
	2	-2.96	1.411	0.533	-7.47	1.56
	3	3.40	1.426	0.340	-1.16	7.97
	4	1.87	1.411	0.946	-2.65	6.39
	5	.56	1.519	1.000	-4.31	5.42
	6	3.44	1.581	0.475	-1.62	8.51
	7	-1.16	2.320	1.000	-8.59	6.27
	8	0.89	1.713	1.000	-4.60	6.38
	9	2.87	1.445	0.607	-1.75	7.50

NOTE: Mean difference marked with "*" is significant at the 0.05 level.

Appendix 4e Table 8: 2006 multiple comparisons - dependent variable: value added score

Test: Tukey HSD

(I) Faculty category	(J) Faculty category	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Upper bound	Lower bound
1	2	-2.292	2.159	0.979	-9.03	4.45
	3	-3.416	1.910	0.690	-9.38	2.55
	4	-3.897	1.786	0.420	-9.47	1.68
	5	-1.435	2.812	1.000	-10.21	7.34
	6	-0.149	2.059	1.000	-6.58	6.28
	7	-6.035	2.906	0.491	-15.11	3.04
	8	-0.935	2.732	1.000	-9.46	7.59
	9	0.142	1.803	1.000	-5.49	5.77
2	1	2.292	2.159	0.979	-4.45	9.03
	3	-1.124	1.786	0.999	-6.70	4.45
	4	-1.605	1.654	0.988	-6.77	3.56
	5	0.857	2.730	1.000	-7.66	9.38
	6	2.143	1.945	0.974	-3.93	8.21
	7	-3.743	2.826	0.924	-12.56	5.08
	8	1.357	2.647	1.000	-6.91	9.62
	9	2.434	1.671	0.875	-2.78	7.65
3	1	3.416	1.910	0.690	-2.55	9.38
	2	1.124	1.786	0.999	-4.45	6.70
	4	-0.481	1.312	1.000	-4.58	3.62
	5	1.981	2.538	0.997	-5.94	9.90
	6	3.267	1.665	0.571	-1.93	8.46
	7	-2.619	2.641	0.986	-10.86	5.63
	8	2.481	2.448	0.984	-5.16	10.12
	9	3.558	1.335	0.164	-0.61	7.73
4	1	3.897	1.786	0.420	-1.68	9.47
	2	1.605	1.654	0.988	-3.56	6.77
	3	0.481	1.312	1.000	-3.62	4.58
	5	2.462	2.446	0.985	-5.17	10.10
	6	3.748	1.521	0.254	-1.00	8.50
	7	-2.138	2.553	0.996	-10.11	5.83
	8	2.962	2.353	0.942	-4.38	10.31
	9	**4.039(*)**	1.151	0.015	0.45	7.63
5	1	1.435	2.812	1.000	-7.34	10.21
	2	-0.857	2.730	1.000	-9.38	7.66
	3	-1.981	2.538	0.997	-9.90	5.94
	4	-2.462	2.446	0.985	-10.10	5.17
	6	1.286	2.652	1.000	-6.99	9.56
	7	-4.600	3.352	0.907	-15.06	5.86
	8	0.500	3.202	1.000	-9.50	10.50
	9	1.576	2.458	0.999	-6.10	9.25

[2006 multiple comparisons table continued …]

(I) CRSECAT	(J) CRSECAT	Mean difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Upper Bound	Lower Bound
					-6.28	6.58
	2	-2.143	1.945	0.974	-8.21	3.93
	3	-3.267	1.665	0.571	-8.46	1.93
	4	-3.748	1.521	0.254	-8.50	1.00
	5	-1.286	2.652	1.000	-9.56	6.99
	7	-5.886	2.751	0.448	-14.47	2.70
	8	-0.786	2.566	1.000	-8.80	7.23
	9	0.291	1.541	1.000	-4.52	5.10
7	1	6.035	2.906	0.491	-3.04	15.11
	2	3.743	2.826	0.924	-5.08	12.56
	3	2.619	2.641	0.986	-5.63	10.86
	4	2.138	2.553	0.996	-5.83	10.11
	5	4.600	3.352	0.907	-5.86	15.06
	6	5.886	2.751	0.448	-2.70	14.47
	8	5.100	3.285	0.829	-5.15	15.35
	9	6.176	2.564	0.283	-1.83	14.18
8	1	0.935	2.732	1.000	-7.59	9.46
	2	-1.357	2.647	1.000	-9.62	6.91
	3	-2.481	2.448	0.984	-10.12	5.16
	4	-2.962	2.353	0.942	-10.31	4.38
	5	-0.500	3.202	1.000	-10.50	9.50
	6	0.786	2.566	1.000	-7.23	8.80
	7	-5.100	3.285	0.829	-15.35	5.15
	9	1.076	2.366	1.000	-6.31	8.46
9	1	-0.142	1.803	1.000	-5.77	5.49
	2	-2.434	1.671	0.875	-7.65	2.78
	3	-3.558	1.335	0.164	-7.73	0.61
	4	-4.039(*)	1.151	0.015	-7.63	-0.45
	5	-1.576	2.458	0.999	-9.25	6.10
	6	-0.291	1.541	1.000	-5.10	4.52
	7	-6.176	2.564	0.283	-14.18	1.83
	8	-1.076	2.366	1.000	-8.46	6.31

ANOVA: Category of time spent in IT Activities

Appendix 4e Table 9: 1998 Descriptives

Category of time spent in IT activities	N	Mean VAS	Std. deviation	Std. error	95% confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
1	73	**-1.61**	2.920	0.342	-2.29	-0.93	-10	6
2	20	**-1.66**	2.528	0.565	-2.84	-0.48	-6	3
3	50	**-0.41**	3.324	0.470	-1.35	0.54	-6	12
4	52	**3.63**	5.584	0.774	2.08	5.19	-6	12
Total	195	**0.09**	4.428	0.317	-0.53	0.72	-10	12

Appendix 4e Table 10: 2006 Descriptives

Category of time spent in IT activities	N	Mean VAS	Std. deviation	Std. error	95% confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
1	102	**6.24**	6.205	0.614	5.02	7.45	-5	22
2	81	**6.14**	9.883	1.098	3.95	8.32	-12	41
3	80	**4.28**	7.631	0.853	2.58	5.97	-11	24
4	88	**5.32**	7.458	0.795	3.74	6.90	-13	22
Total	351	**5.54**	7.810	0.417	4.72	6.36	-13	41

Appendix 4e Table 11: 1998 Test of homogeneity of variances

Levene statistic	df1	df2	Sig.
17.805	3	191	0.000

Appendix 4e Table 11: 2006 Test of homogeneity of variances

Levene statistic	df1	df2	Sig.
2.164	3	347	0.092

Appendix 4e Table 12: 1998 ANOVA

	Sum of squares	df	Mean square	F	Sig.
Between groups	937.068	3	312.356	20.812	**0.000**
Within groups	2866.633	191	15.009		
Total	3803.700	194			

Appendix 4e Table 13: 2006 ANOVA

	Sum of squares	df	Mean square	F	Sig.
Between groups	210.405	3	70.135	1.151	0.328
Within groups	21,140.900	347	60.925		
Total	21,351.305	350			

Appendix 4e Table 14: 1998 multiple comparisons- dependent variable: value added score

		Mean difference (I-J)	Std. error	Sig.	95% confidence interval	
(I) Category of IT use	(J) Category of IT use				Lower bound	Upper bound
1	**2**	0.05	0.978	1.000	-2.48	2.59
	3	-1.20	0.711	0.333	-3.04	0.64
	4	**-5.24***	0.703	0.000	-7.06	-3.42
2	**1**	-0.05	0.978	1.000	-2.59	2.48
	3	-1.25	1.025	0.614	-3.91	1.40
	4	**-5.29***	1.019	0.000	-7.94	-2.65
3	**1**	1.20	0.711	0.333	-0.64	3.04
	2	1.25	1.025	0.614	-1.40	3.91
	4	**-4.04***	0.767	0.000	-6.03	-2.05
4	**1**	**5.24***	0.703	0.000	3.42	7.06
	2	**5.29***	1.019	0.000	2.65	7.94
	3	**4.04***	0.767	0.000	2.05	6.03
NOTE: Mean difference marked with "*" is significant at the .05 level.						

Appendix 4e Table 15: 2006 multiple comparisons- dependent variable: value added score

		Mean Difference (I-J)	Std. Error	Sig.	95% confidence interval	
(I) Category of IT use	(J) Category of IT use				Lower bound	Upper bound
1	2	0.099	1.162	1.000	-2.90	3.10
	3	1.960	1.166	0.335	-1.05	4.97
	4	0.917	1.136	0.851	-2.01	3.85
2	1	-0.099	1.162	1.000	-3.10	2.90
	3	1.861	1.230	0.431	-1.32	5.04
	4	0.818	1.202	0.905	-2.29	3.92
3	1	-1.960	1.166	0.335	-4.97	1.05
	2	-1.861	1.230	0.431	-5.04	1.32
	4	-1.043	1.206	0.823	-4.16	2.07
4	1	-0.917	1.136	0.851	-3.85	2.01
	2	-0.818	1.202	0.905	-3.92	2.29
	3	1.043	1.206	0.823	-2.07	4.16
NOTE: Mean difference marked with "*" is significant at the .05 level.						

ANOVA: Category of time spent in non-IT Activities

Appendix 4e Table 16: 1998 Descriptives

Category of time spent in non-IT Activities	N	Mean VAS	Std. deviation	Std. error	95% confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
1	46	-0.34	3.602	0.531	-1.41	0.73	-4	11
2	52	-0.92	3.470	0.481	-1.88	.005	-10	6
3	50	-0.70	3.805	0.538	-1.78	0.38	-6	12
4	47	2.47	5.783	0.844	0.77	4.16	-6	12
Total	195	0.09	4.428	0.317	-0.53	0.72	-10	12

Appendix 4e Table 17: 2006 Descriptives

Category of time spent in non-IT Activities	N	Mean VAS	Std. deviation	Std. error	95% confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
1	115	6.39	7.097	0.662	5.08	7.70	-5	41
2	66	5.58	9.402	1.157	3.26	7.89	-12	41
3	85	5.36	8.208	0.890	3.59	7.14	-11	24
4	85	4.52	6.926	0.751	3.02	6.01	-13	19
Total	351	5.54	7.810	0.417	4.72	6.36	-13	41

Appendix 4e Table 18: 1998 Test of homogeneity of variances

Levene statistic	df1	df2	Sig.
8.891	3	191	**o.000**

Appendix 4e Table 19: 2006 Test of homogeneity of variances

Levene statistic	df1	df2	Sig.
1.372	3	347	0.251

Appendix 4e Table 20: 1998 ANOVA

	Sum of squares	df	Mean square	F	Sig.
Between groups	357.867	3	119.289	6.612	**0.000**
Within groups	3445.834	191	18.041		
Total	3803.700	194			

Appendix 4e Table 21: 2006 ANOVA

	Sum of squares	df	Mean square	F	Sig.
Between groups	174.875	3	58.292	0.955	0.414
Within groups	21,176.430	347	61.027		
Total	21,351.305	350			

Appendix 4e Table 22: 1998 multiple comparisons- dependent variable: value added score

(I) Category of non-IT use	(J) Category of non-IT use	Mean difference (I-J)	Std. error	Sig.	95% confidence interval	
					Lower bound	Upper bound
1	2	0.58	0.860	0.907	-1.65	2.81
	3	0.37	0.868	0.974	-1.88	2.62
	4	-2.80*	0.881	0.009	-5.09	-0.52
2	1	-0.58	0.860	0.907	-2.81	1.65
	3	-0.21	0.841	0.994	-2.39	1.97
	4	-3.38*	0.855	0.001	-5.60	-1.17
3	1	-0.37	0.868	0.974	-2.62	1.88
	2	0.21	0.841	0.994	-1.97	2.39
	4	-3.17	0.863	0.002	-5.41	-0.93
4	1	2.80*	0.881	0.009	0.52	5.09
	2	3.38*	0.855	0.001	1.17	5.60
	3	3.17*	0.863	0.002	0.93	5.41
NOTE: Mean difference marked with "*" is significant at the .05 level.						

Appendix 4e Table 23: 2006 multiple comparisons- dependent variable: value added score

(I) Category of non-IT use	(J) Category of non-IT use	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
1	2	0.816	1.206	0.906	-2.30	3.93
	3	1.027	1.117	0.795	-1.86	3.91
	4	1.874	1.117	0.338	-1.01	4.76
2	1	-0.816	1.206	0.906	-3.93	2.30
	3	0.211	1.282	0.998	-3.10	3.52
	4	1.058	1.282	0.842	-2.25	4.37
3	1	-1.027	1.117	0.795	-3.91	1.86
	2	-0.211	1.282	0.998	-3.52	3.10
	4	0.847	1.198	0.894	-2.25	3.94
4	1	-1.874	1.117	0.338	-4.76	1.01
	2	-1.058	1.282	0.842	-4.37	2.25
	3	-0.847	1.198	0.894	-3.94	2.25
NOTE: Mean difference marked with "*" is significant at the .05 level.						