ENGINEERING MATHEMATICS AND VIRTUAL LEARNING ENVIRONMENTS: A CASE STUDY OF STUDENT PERCEPTIONS

by

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Engineering Mathematics and Virtual Learning Environments: A Case Study of Student Perceptions

Abstract

The study involved BTec National (level 3) engineering students studying at a large Further Education College in the South West region. The disciplines of Electrical/Electronic, Mechanical, Operations and Maintenance, Manufacturing, Telecommunications and Fabrication where all included in the study. Several students were sent by their employers on day release programmes and apprenticeships, and these formed the majority of the part time students. There were also other employed students who attended full time for terms 1 and 3 as part of a block release programme. The remaining students were full time, and mainly 16-18 years old.

The study focused upon the core mathematics module everyone studied, and mathematical resources which were available through a virtual learning environment. The resources used layering, enabling earlier work to be built on and applied. Two separate cohorts were studied after substantial changes had been made to the qualification standards.

The main findings were that the mathematics resources were very useful support, had a significant positive impact on student success, and enhanced the student experience. They helped part time students, especially, to improve their confidence and their achievements. The unlimited availability of these resources were a major consideration in their usefulness. The use of layering within the mathematics unit enabled better recall and comprehension.

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ABBREVIATIONS

3D	Three dimensional
3G	3rd Generation
A2	Advanced level 2
A levels	Advanced levels
AAMT	Australian Association of Mathematics Teachers
AS	Advanced Subsidiary
AutoCAD	Auto Computer Aided Design
AVCE	Advanced Vocational Certificate of Education
BBC	British Broadcasting Company
Becta	British Educational Communication and Technology Agency
CAL	Computer Assisted Learning
CCP	City College Plymouth
CD-ROM	Compact Disc – Read Only Memory
CETIS	Centre for Educational Technology and Interoperability Standards
DML	Devonport Management Limited
EITB	Engineering Industry Training Board
FE	Further Education
FENTO	Further Education National Training Organisation
FTE	Full Time Equivalent
GCE	General Certificate of Education
GCSE	General Certificate of Secondary Education
HE	Higher Education
HMI	Her Majesty’s Inspectorate
HTML	Hyper Text Mark-up Language
ICS	Integrated Case Studies

ICT	Information Communication Technology
ILT	Information Learning Technology
IMS	Integrated Management Systems
IT	Information Technology
JISC	Joint Information Services Committee
LSC	Learning and Skills Council
MLE	Managed Learning Environment
NCETM	National Centre for Excellence in Mathematics Teaching
NFER	National Foundation for Educational Research
NGfL	National Grid for Learning
NOF	New Opportunities Fund
NQF	National Qualification Framework
O levels	Ordinary levels
OECD	Organisation for Economic Co-operation and Development
OFSTED	Office for Standards in Education
PC	Personal Computer
PLE	Personal Learning Environment
QCA	Qualifications and Curriculum Authority
QCDA	Qualifications and Curriculum Development Agency
RAG	Red, Amber, Green
SEFI	Société Européenne pour la Formation des Ingenieurs
SEFI-MWG	Société Européenne pour la Formation des Ingenieurs – Mathematics Working Group
SENDA	Special Educational Needs and Disability Act (2001)
SET	Science, Engineering and Technology
SMS	Short Message Service
SPSS	Statistical Package for the Social Sciences

TV	Television
UAE	United Arab Emirates
UCAS	Universities and Colleges Admissions Service
UK	United Kingdom
VLE	Virtual Learning Environment

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ACKNOWLEDGEMENT

I began this study for several reasons. The foremost reason was to keep my friend, and colleague, Brian Watson, company and to provide him with support on what appeared to be a very daunting task. Without his initial encouragement, I would never have dreamt of attempting anything so academic. Having decided to *"keep Brian company"* the concept of actually getting a PhD became the main goal. I needed to prove to myself (and those demons from my past who had told me continually that I was stupid) that I could achieve this standard of work and apply myself to a long term task.

The total belief of my son, who was a great source of encouragement, helped me to overcome my fears and make the first tentative steps to talk to Ted Graham and John Berry. I could scarcely believe my ears when they agreed for me to commence the qualification through the MPhil/PhD route. I knew at that point that whatever else happened, I could not let them down for having such faith in me.

Having taking this initial step – I had no idea what I wanted to research. I approached my then Head of Faculty and asked him what he would like me to research on behalf of the College, and that was the beginning of a very long, hard, but enjoyable quest for my holy grail. I have been exceptionally fortunate that City College Plymouth have paid the majority of the course fees for the duration of the qualification, and initially even gave me a timetable space to attend the university meetings. They also kindly allowed me to use the College students as the subjects for my research.

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AUTHOR'S DECLARATION

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award.

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The University of Plymouth's research training MRes information was studied prior to the start of this study. The author attended regular weekly meetings at the Centre for Teaching Mathematics to discuss research papers and research techniques from 2003. The author also attended the bi-annual Graduate Student Week programme at the University of Plymouth throughout the duration of this research as well as a variety of conferences which are listed below.

Conferences Attended:
9-11th July 2003 BERA/ERSC Conference, Reading University: Multidisciplinary Development Programme for Doctoral Students Engaged in Educational Research
9th July 2004 School for Mathematics and Statistics Subject Conference, University of Plymouth
8th July 2005 School for Mathematics and Statistics Subject Conference, University of Plymouth
29th June 2006 University of Plymouth Colleges Social Science Subject Forum Annual Conference
4th July 2006 University of Plymouth Colleges Summer Conference: Reflections on Innovation and Development
7th July 2006 School for Mathematics and Statistics Subject Conference, University of Plymouth
3rd October 2007 14-19 Reform Regional Conference, Bristol
14th March 2007 Annual Management Conference: Towards Outstanding
29th March 2007 SW Regional Aim Higher Conference.
Presented: 14-19 IT Diploma and the potential impact for university courses.
23rd November 2007 SW Regional Aim Higher Conference.
Presented: 14-19 IT Diploma and Gateway Bid for Plymouth
27th February 2008 Annual Management Conference: The WOW Factor
25th February 2009 Annual Management Conference: Success and the City
3rd July 2009 School for Mathematics and Statistics Subject Conference, University of Plymouth
24th February 2010 Annual Management Conference: Strictly Brilliant
2nd March 2011 Annual Management Conference: Student Success

This thesis contains seventy four thousand, two hundred and forty words within the main body, excluding figures and tables.

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Signed ……………………………………………

Date ..…………19th March 2011…………………

CHAPTER 1

INTRODUCTION TO THE RESEARCH

1.1 Background

For several years there has been a perceived problem with students not achieving the mathematics unit of BTec level 3 National qualifications in engineering at the College. This has also been identified as a national problem, with mathematics, generally. Several of the local employers had requested extra support for mathematics but had problems releasing students to spend time at the College. Other than providing formal lectures, this meant another solution needed to be found, which was when the idea of using the Virtual Learning Environment (VLE), Blackboard, was proposed.

There was a College initiative to make fuller use of online learning through the VLE, as stated in the College's Information and Learning Strategy 2002/05. This seemed to be the ideal opportunity to make use of the VLE to address the issues raised by both the employers and the College strategy. It also corresponded with the wholesale change of BTec syllabi whose new standards came into force for the academic year 2002/03.

This initially meant producing mathematics learning materials specifically aimed at National level engineering students for use with Blackboard. This learning material could then be posted onto the intranet via the College's VLE. This also gives scope for the material to be developed further and enriched on an on-going basis.

Material was prepared by the researcher, based on the proposed weekly lecture content. This was posted as PowerPoint presentations on the Blackboard platform. The lectures were delivered by the researcher and another mathematics lecturer during the study. The same sessions and sequence were delivered by both staff. It was important to determine whether problems existed associated with Blackboard, such as gaining access to the materials. It was also necessary to gain familiarity with Blackboard. After the one year trial the materials were re-posted as full lectures with accompanying notes and presentations. The focus of the research considered the students' perceptions of the VLE as well as their results from using it.

The study was based around all the engineering students in the Faculty of Technology. This consisted of 112 students in 04/05 (81 part time, 31 full time) and 125 in 05/06 (91 part time, 34 full time). The breakdown is given below. In the first cohort (04/05) there were six separate disciplines spread across nine groups, as indicated in Table 1.1. The only disciplines which contained female students were the part time electrical/electronic and the full time manufacturing.

04/05 *N* = 112		
Attendance Mode	**Disciplines**	**Groups**
Part Time *N* = 81	Operations & Maintenance *N* = 7	*N* = 7
	Electrical & Electronic *N* = 30	Group A *N* = 15
		Group B *N* = 15 (Includes 1 female)
	Mechanical *N* = 30	Group A *N* = 14
		Group B *N* = 16
	Fabricators *N* = 14	*N* = 14
Full Time *N* = 31	Manufacturing *N* = 18	Group A *N* = 8
		Group B *N* = 10 (Includes 2 females)
	Telecommunications *N* = 13	*N* = 13

Table 1.1: Constitution of the 04/05 Cohort

In the second cohort (05/06) there were five separate disciplines spread across nine groups, as shown in Table 1.2. The overall numbers per cohort were roughly the same as in the previous year. The break down into full and part time was also very similar. However, there are more mechanical students and no fabricators in this cohort. The other disciplines, although split differently, are much the same as the previous cohort, including the number of female students.

05/06 N = 125		
Attendance Mode	**Disciplines**	**Groups**
Part Time N = 91	Operations & Maintenance N = 7	N = 7
	Electrical & Electronic N = 37	Group A N = 15
		Group B N = 12 (Includes 1 female)
		Group C N = 10
	Mechanical N = 47	Group A N = 13
		Group B N = 18
		Group C N = 16
Full Time N = 34	Manufacturing N = 17	N = 17 (Includes 2 females)
	Telecommunications N = 17	N = 17

Table 1.2: Constitution of the 05/06 Cohort

1.2 Aims of the Research

The main question to be answered is whether the use of a VLE enhances student learning of mathematics. Within this it will be necessary to look at students' attitudes, achievement and ability in both mathematics and ICT; their support requirements; their engagement with using the VLE materials; and the overall viability of such a resource. To answer the over-arching question there are three main areas that require investigation. These areas are

1. Virtual Learning Environments
2. Layering Effect and
3. Engineering First, Mathematics Second.

The first two areas fall within the scope of this investigation, but the third area is more likely to be a follow up study due to the time required to fully link together all the mathematics resources with the engineering resources.

1.2.1 Virtual Learning Environments

Initially, this study intends to investigate how the new approach of capturing the lecture and PowerPoint slides and posting it onto the Blackboard platform affects both the learning environment and the learners experience.

The investigation into the learning environment firstly needs to address how the resources are used:

- where they are used
- when they are used
- what areas are accessed
- by whom they are used
- how frequently they are used
- the duration of use
- how this meets the College ILT Strategy 2002/5

Secondly there is a need to address the viability of the VLE and Blackboard resources with regards to:

- financial costs of setting up the systems
- the ease with which the systems can be used
- time required in preparation
- how this meets the College ILT Strategy 2002/05

The learner’s experience needs to look at different attributes:

- the usefulness of the resource
- why the resource is useful
- whether the resource meets individual expectations

- what effect the resource has on attitudes to both mathematics and ICT
- how this meets the College Learner's Policy 2004
- how this meets the College ILT Strategy 2002/05

1.2.2 Layering Effect

Secondly, the study intends to investigate the effect of layering the unit into criteria. Instead of working with a topic area to its full conclusion before moving on to another topic area, the layering system deals with a topic at a basic level initially, then revisits it later in the course at a higher level, and so on. As the new unit assessment methods are criterion based and all of the pass criteria are needed to achieve success, the layering method allowed less able students to achieve the unit whilst still stretching the more able. There is no longer an intermingling of all topic areas at pass level and the interdependency of methods and topics is only introduced at merit levels. This allows a revisiting of earlier concepts, and it is by using these concepts again that there is more likelihood of refreshing ideas, thereby overcoming the recall problems of dealing with topic areas in separate blocks. This means looking at comprehension against recall and attainment. In order to address this issue, comparisons over time will be required.

The following will need to be considered:

- comparisons of results prior and post Virtual Learning Environment
- comparisons of results pre and post 2002/03 standards

1.2.3 Engineering First, Mathematics Second

Thirdly the new structure will enable the unit material to not only stand alone in its own right as a subject area, but also to link into engineering units, so that the concept of “Engineering first, Mathematics second” can be investigated. This will allow the mathematical theory to be directly linked to its applications. This is part of the second phase of the study when the materials are enhanced and enriched.

The linking will be a two way process so that the engineering links directly to the appropriate mathematical theory and vice versa. It is also hoped to include links to external web resources which further back up the inter-dependency of the subject areas.

This section will look into all the aspects of both of the previous study areas by looking at the learners’ experience, the learning environment, comprehension against recall and attainment. It will need to make comparisons pre and post linking, enriching and enhancing. This will require further in depth analysis, so may fall outside the time limits of the initial research (as outlined in aims one and two) and become a future research proposal.

In order to investigate the student experience it will be necessary to conduct a study, spread over several years as detailed in Cohen, Manion and Morrison (2000). This will involve questionnaires before, during and at the end of each course looking at attitudes to mathematics and information and communication technology (ICT) as well as VLE usage. Prior mathematical qualifications and final achievements will also be examined. Interviews will be set up with small groups to gain feedback on their experiences. There will also be follow up interviews with individual students to get more in-depth information to further the investigation. The rationale behind this is discussed in more detail in Chapter 5.

1.3 Research Questions

The research question is:

> **"Does the use of a virtual learning environment enhance engineering students' learning of mathematics?"**

Other questions that arise from this are:

- How are the resources used?
- How viable are the resources?
- What is the effect of layering into criteria?
- What is the learner's experience?

1.4 Outline of Research

The research is written up into chapters to make it easier to follow. The data chapters are summarised in the conclusion chapter, so that readers wishing to skip the finer details can do so, without losing the focus of the evidence. The background to the research is also given in detail, so that the reader can build up their own mental picture of the scenario in which the research takes place. They will also be aware of the changes that have occurred during the period of this research, this is to the computing system, the mathematics and to the students themselves. This will help to clarify the way that the use of VLEs has developed and the changes of perception that have occurred during this phase. The research takes an impartial view and presents the facts that arise from the data collected. Any imbalance is presented as such and discussed. VLEs are one of the more recent technological advances that have been embraced by education in general, and so any findings – positive or negative – will be useful for others to note for their own ends.

The research will take place over two years, following a pilot study. Student perceptions of the VLE will form a key part of the analysis, along with factual evidence from results. The reader will be taken on a journey through this research so that they can follow the thought processes behind the actions taken, and also have sufficient evidence presented so that they too can make their own conclusions in an informed way, and compare them to the conclusions reached within this study.

The journey begins with the literature review (Chapter 2) – an insight into what others have already found and many of the historical factors that impact upon the research in question. This is used to inform many of the decisions and pathways that the research took as it meandered its way through the raft of questions that needed to be answered. Having looked at various ways forwards, the next two chapters (3 and 4) focus on the background in which the research is taking place. There is information about the institution that the research took place in, details about the students and their courses, how things have been in the past, and the way that they are expected to progress, as well as a timeline which details changes that have occurred within the computing/VLE area. Even in the short period of this study this latter area has accelerated and changed tremendously, so what was available at the start is not the same as at the end, with some experimental technologies falling by the wayside through lack of updating, financial restraints and not being user-friendly.

Once the background has been laid out, the journey becomes more focused. The next chapter, (Chapter 5), looks at the ways the research questions can be answered. There is a lot of discussion about different ways forward and why they could be useful or not. Now that the journey has moved forwards, the next chapters (6, 7, 8 and 9) deal with the ways of gathering the data to answer the research questions, and the presentation of the data that is obtained. The data is very extensive, so has been split up to make it easier to understand. The pure statistical testing has been separated out to make it clearer.

The final part brings everything back together again. Chapter 10 delivers the conclusions and evaluations with Chapter 11 providing recommendations and ways forward for any future research. The overarching conclusions have been kept separate from the data chapters to make the whole more accessible to all readers.

1.5 Summary

This chapter has outlined the background to the research proposal and explained how this links to the rationale for the use of VLEs. It has also set out the aims of the research and given insights into how these aims can be met. Beyond this it has given an insight as to how this research has been written up and why it has been put together in the way that it is being presented. It explains why the data chapters are almost a separate entity to the rest of the work, but also why they are the heart of the study as well.

CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Introduction

This chapter firstly looks at the history of the mathematics problem from national, engineering and syllabus perspectives. Secondly it looks at the use of ICT from an historical background, its use in designing resources and a way of evaluating its use through a "conversational framework". This then leads on to e-learning - its focus, associated learning styles and general usage. The suggested solutions to date are also examined.

2.2 The Mathematics Problem

Mathematics has taken quite a battering over recent years. It is perceived by many as an irrelevant and difficult subject. Anecdotes are frequently quoted of "I was never any good at maths", "I never understood it", "Never needed any of that algebra stuff". Indeed, even professional lecturing staff have been heard to say that they "can't do maths". So, is it any wonder that, even in the field of engineering, mathematics is regarded in the same light? Maybe there is a problem, but what evidence is there?

In order to discuss this more fully it will be necessary to split this into three separate sections, namely national, engineering and syllabus perspectives.

2.2.1 National Perspective

The acknowledgement of a problem in the early 1980's came out of the Cockcroft report, Mathematics Counts: Report of the Committee of Inquiry into the Teaching of Mathematics in Schools under the Chairmanship of Dr W H

Cockcroft (1982). In his introduction Cockroft quotes from earlier reports of Her Majesty's Inspectorate (HMI) (1876), the Board of Education Report (1925) and the Mathematical Association Report (1954) to:

> *"draw attention to the allegedly poor mathematical standards of the day"*

He first acknowledges the possibility of a problem when talking about mathematical notation, where he states:

> *This use of notation, its interpretation and the underlying abstract ideas and concepts involved prove to be a stumbling block to many people"*
>
> (Page 3)

He then gives a possible reason for this finding:

> *"Mathematics is not used constantly like a native language. It needs learning and practising as it is very precise. This takes time to become familiar with and to become confident in using".*
>
> (Page 5)

This was clearly not the first time the problem had emerged, but became a milestone in its measurement. Galbraith and Haines (1997) comment that despite a succession of studies about tertiary mathematics students (Buckland, 1969; Gray, 1975; Clement et al, 1980; Galbraith, 1982; and Tall and Razali, 1993) many students continued to lack adequate procedural and conceptual knowledge of mathematics and were unable to overcome this lack of knowledge. The studies quoted by Galbraith and Haines span the Cockcroft report, and are showing no change to the situation. As these are based on studies from Australia, the problem is clearly not confined to the UK.

During 1995 several reports were commissioned to look in to 'the decline' in students' mathematical abilities. The very commissioning of these reports points to a perceived problem in this area. Two of the more major reports were commissioned by the Engineering Council (Sutherland and Pozzi, 1995), and by the London Mathematical Society, the Institute of Mathematics and its Applications and the Royal Statistical Society (Howson et al 1995). The third of the major reports reported the findings of a working group set up under the auspices of the major UK engineering and mathematics institutions including accrediting bodies for engineering degrees (James et al 1995). All reported the decline in standards as a cause for concern.

However, Edwards (1997):

> "*detected an improvement in students' abilities to abstract, but a decline in students' ability to identify and use appropriate mathematical tools."*
>
> (Page 126)

This reflected a change of emphasis that had occurred within school mathematics syllabi. Sir Ron Dearing (1996) in his Review of Qualifications for 16-19 Year Olds Full Report comments (Page 9, para 2.32), that universities are saying that it may be necessary to move to a 4 year degree course unless the mathematical standards of those presenting themselves for degree courses in physical sciences are improved.

This is further backed up by the National Foundation for Educational Research (NFER) (1996) study, "The Take-Up of Advanced Mathematics Courses: A Research Study". The major cause of non-completion of students studying exclusively mathematics and science A levels is quoted as being difficulty with mathematics, which is commonly perceived as being difficult and dull, (page 96, para 10.69).

The Engineering Council (2000) agrees that the mathematics problem has got steadily worse since the mid 1990's. This is based on the earlier evidence taken from the Institute of Physics (1994), the Engineering Council (1995), the Institute of Mathematics (1995) and the London Mathematical Society (1995) who all looked at the sixth form/higher education interface. The problem highlighted is the:

> "*lack of fluency and reliability in numeric and algebraic manipulation and simplification*".
>
> (Page 1)

Meek (2001) reports Ken Todd's analysis of mathematical performance of first year electronics students at York University. The analysis was completed over fifteen years and a "*severe decline*" was found, despite the students having the same A level grade passes.

Kent (2002) also found that the highest failure rates in first year courses were related to mathematics courses. Once again the "*lack of fluency with mathematical symbolism*" is given as the reason for failure, (Page 57).

If this is combined with the perception that A level mathematics is difficult to pass (Crowther et al 1997) and that much of the content is irrelevant and uninteresting with outdated delivery (Curran and Middleton 1995, Coxhead 1997) then more students will choose alternative options, reducing the uptake of the subject at the higher levels.

Cox et al (1995) believe that part of the problem centres around the content-based approach to the curriculum. This view may be important in terms of checking accumulated knowledge as well as in the delivery of the content.

Greene (1992) warns:

> *"We are far too prone to mistake an ability in the student to reproduce an elegant and powerful piece of mathematics for real depth of understanding. The ability to regurgitate theory or even to apply it to standard-format examination questions is a far cry from the true internalisation indicated by the ability to apply it meaningfully in different contexts."*
>
> (Page 198)

A content-based curriculum linked with criterion-based outcomes could easily result in a 'teach-test-forget' attitude, compounding the problem further. Professor Smith's Inquiry into Post-14 Mathematics Education (2004), page 3, para 0.13, also found that mathematics was perceived as relatively difficult, the curriculum as uninteresting, not motivating and that there was a lack of awareness among students of how important mathematical skills would be for future career options and advancement.

This lack of any measurable change of perception seems to be the real underlying problem. If the majority of students regard something as being difficult, then clearly, it must be! Things that are difficult are often seen as being irrelevant in order to justify avoidance. Perhaps this together with the changes in emphasis that have occurred in school mathematics are heightening the awareness of the original problem and compounding it – rather like the snowball rolling down the mountain. It starts small, but becomes larger on its journey.

2.2.2 Engineering Perspective

All engineering students need a sound mathematical basis from which to start, but the mathematics problem still exists, despite the mathematical emphasis of the discipline. The mathematics problem also needs to be discussed from an engineering perspective.

In Cockroft's report, pages 12 -13, paras 41 and 43, he acknowledges that there was widespread criticism from the Engineering Industry Training Board (EITB) in both 1975 and 1976 following complaints about the *"lack of mathematical competence of some school leavers"* from employers during 1973 and 1974. The criticisms were directed at low levels of attainment in arithmetic skills. It was felt that:

> *"an understanding of concepts, together with an ability to acquire planning and diagnostic skills was of great importance to craft and technician employees".*
>
> (Page 13)

This was also the finding of Dearing (1996), para 2.8, who found that:

> *"Employers want entrants with a good command of language, both oral and written, and also a good grasp of basic arithmetic without the help of a calculator".*
>
> (Page 6)

This is why greater inclusion of Key Skills in Application of Number at varying levels was recommended for all qualifications.

The engineering profession is based on the application of the work of mathematicians and scientists. This has to be reflected in the core subjects studied. Mathematics is the key and is needed by all engineers, (Bishop et al, 1992; Jackson, 1994; Jenvey, 1994; and Barry, 1995). Jackson (1994) actually defines what he believes a professional engineer to be with reference to mathematics.

> "*A professional engineer applies a sound knowledge of the principles of science and mathematics to this transformation process*."
>
> (Page 683)

However, engineering students claim that mathematics is not something they use when they work in industry, indeed it is something to avoid! This perception has to be a hindrance to learning mathematics, but once mathematics becomes "*useful*" it is no longer regarded as mathematics, (Maull, 1995 and Maull, 1998). Greene (1992) warns that the choice of an engineering career may be of necessity rather than by passion, so participants may not be enthusiastic or even interested.

Crowther et al (1997) believe that the requirement to increase the number of students entering higher education has resulted in the lowering of the minimum entry requirements for an engineering degree. By accepting a wider and more varied range of qualifications greater input is required to keep the degree qualification standards unchanged. Also, as there has already been a problem for more than 20 years, it is not just a National Curriculum problem, (Cox et al, 1995 and Crowther et al, 1997). Huntley (1995) quantifies the changes to entry qualifications. Between 1988 and 1993 the UK and European countries higher education student population increased by 44% to nearly 1 million, whilst the participation of 18 – 19 year olds changed from 15% to 28% bringing the UK closer to European and international norms. Professor Todd's evidence (Meek, 2001) would support Crowther et al's (1997) beliefs. If the perception that engineering is "*dirty and unglamorous*" is also combined with courses being seen to be technologically inferior compared to industry, out of date and irrelevant, there has to be a knock on effect to student recruitment and retention. There is also the problem of higher drop out rates on engineering courses – mainly due to failure of the mathematical modules, (Brown, 2003).

The mathematics problem seems to be worsening through other factors, such as changes to syllabus requirements, wider recruitment fields, more varied pathways and modes of attainment. If we add to this the mismatch between the expectations of industry and those of students, as identified in the Progress Project then engineering too has its own problems, (Cox et al, 1995 and Brown, 2003).

The problems were such that in 1995 a report into the mathematics situation was commissioned by the Engineering Council (Sutherland and Pozzi, 1995) and a working party set up by the engineering institutions (James et al, 1995) also reported about the same issue. This was mentioned in Section 2.2.1.

Jackson (1994) looks at the role of the engineer, and how mathematics fits into this role. He sees a professional engineer as using mathematics to

> "*create mathematical models of physical situations that have quantitative predictive power, analyse data to draw inferences from the data or to extrapolate from the analysis, and to replace experiments that are possibly costly, time-consuming or even impossible to perform, e.g. computer simulations*".
>
> (Page 683).

Thus mathematics is indeed central to being an engineer. This agrees with Stevens (2003) who sees understanding and responsibility for design as key factors for an engineer. They would need to be able to predict for their design, which requires a sound mathematical background.

The Engineering Council (2000) concluded that the mathematics problem had become steadily worse since the mid 1990's.

> "*Mathematics, Science and Engineering Departments appear unanimous in their perception of a qualitative change in the preparedness of incoming students – even among the very best and students enrolling on*

> *courses making heavy mathematical demands are hampered by a serious lack of essential technical facility – in particular a lack of fluency and reliability in numeric and algebraic manipulation and simplification*".
> (Page 1)

The Smith Report (2004) refers to the findings of Sir Gareth Roberts (2002) who reported upon the difficulties faced by employers in recruiting appropriately qualified scientists and engineers in Science, Engineering and Technology (SET) for "Success: The Supply of People with Science, Technology, Engineering and Mathematical Skills". The generic problems identified were more acutely noticeable within the mathematics area. The review "SET for Success" clearly states that more engineers are needed, but that their skills are not encouraged, (Roberts, 2002 and Brown, 2003). Indeed, Kent (2002) put this into perspective when he quoted Sir Duncan Michael, former chairman of the engineering consultancy Ove Arup who found that ninety percent of the population are excluded from becoming engineers due to lack of expertise in mathematics as teenagers. If we add to this the high drop out and failure rates associated with mathematical modules, what is left of the eligible ten percent? It is no wonder that there is grave concern being expressed at a government level. As education syllabi below university level are now part of a governmental remit this is where the next step for a possible solution could come from.

2.2.3 Syllabus Perspective

According to Cockcroft's report (1982) there were problems with regard to initial training of craft and technician apprentices. This is referred to on pages 37, 45, 46, paras 130, 131, 163, 164, 166. This was due, in part, to the training for both sets of apprentices being the same, which meant that the craft apprentices *"in particular can be confronted by an unnecessarily taxing programme"*. (Page 37).

However, mathematics at Level 1 during the first year of training is not the major issue; it was more the *“mismatch between the mathematical content of Further Education courses and the future demands of the job”*, (page 46). In order to develop confidence and familiarity with essential topics the mathematical requirements were likely to be greater than the job required; however, this was intended to provide the base of skills required throughout working life.

On page 46, para 166 Cockcroft refers to studies at Bath and Nottingham. These showed that the attitude of students towards mathematics was often more favourable in further education than it had been at school because the applications were more apparent, or seen to be useful in the future.

Brown and Cross (1992) mention the findings of Beale and Bordin (1964) who reported that engineers prefer practicality, objectivity and certainty. However, the new entrants into engineering today are very different from those in the 1992 report. Not only are there more female engineers, the personalities and attitudes of the new engineers is not a perfect match to those in the original study. These changes need to be catered for. If mathematics is looked at, there are two extreme stances that can be taken; either that mathematics is completed by computer packages so it is not necessary to know underlying mathematical principles and that very few engineers use the mathematics that they learnt at university, or, mathematics must be used to explain general principles adequately in engineering as it is the main language of quantitative applications. (Cox, 1995)

Clearly the answer must lie somewhere between these two extremes. However, Fleming (2003) correctly observes

> "*Engineers and mathematicians make their living from problem solving, but both groups seem to be far from finding a solution to the question of what level of mathematics is needed by young engineers*."
>
> (Page 19)

Mathematics is highly sequential, and every detail is critical within a mathematical argument. This frequently results in too much detailed factual information, (Hubbard, 1990). Information overload was also the reason why the intended benchmark syllabus detailed in the Organisation for Economic Co-operation and Development (OECD) 1965 "Mathematical Education of Engineers" was not taken up. The content was just too ambitious, (Barry and Steele, 1993). The European Society for Engineering Education, (SEFI, Société Européenne pour la Formation des Ingenieurs), one of the main engineering education institutions, managed to produce an internationally agreed core curriculum for Europe during the 1980's, which had less content. This was discussed at several international conferences and was worked on by the Mathematics Working Group of the European Society for Engineering Education (SEFI-MWG). It was felt that at secondary level a sound traditional mathematics education was the high priority. This level became known as Core Zero, and was finally published as SEFI Document 92.1 in 1992. It consisted of five main topic areas: Number and algebra, Trigonometry, Euclidean and basic analytical geometry, Differential calculus, and Integral calculus, (Barry and Steele, 1993)

However, it was soon clear that there were international concerns as to how much of Core Zero should be achieved prior to entry into higher education. Much of the Core Zero had been more than adequately covered by A levels, but syllabus changes occurred when GCSEs replaced O levels in 1988. The syllabus changes and the growth of varying qualifications meant that Core Zero was no longer fully covered within the UK, and the UK was beginning to suffer the same problems as their European counterparts. As a consequence a Joint European Project was set up to study this. SEFI-MWG emphasised the use of numerical methods at all curriculum stages to give a background to the ever increasing use of software packages. The curriculum needed to be half traditional (analysis and calculus) with the other half split equally between linear algebra (to support software packages), discrete mathematics (to support computer science and software engineering) and probability and statistics (to develop uncertainty principles), (Barry, 1995).

The changes of syllabus then started to become the major emphasis of the mathematics problem. The change of emphasis and the lesser topic coverage, due to changes in the syllabus, was seen by many academics as a 'watering-down', and consequently this reduction became the new focus of attention, rather than the underlying causes which had arisen from Cockcroft's report. Thus, the syllabus became the cause of all problems, despite Cockcroft in 1982! The reduction of the GCSE syllabus followed by a reduced A-Level mathematics core became the initial focus of attention, as indeed the National Curriculum is now. Hunt and Lawson (1996) indicate that algebraic simplification at entry to higher education has altered from being a topic area the majority do well with, to one that only a minority succeed with. Crowther et al (1997) add to this that the students' expectations at secondary level have also changed alongside the syllabus and staff-student relationships. This change has not occurred in the same way at university; and in industry expectations have altered very little. The blame is clearly targeted towards the syllabus, rather than the student, as indicated by this quote from Crowther et al (1997).

> *"There is no evidence to suggest that the ability of the student is declining but rather that it is the standard of the syllabuses which is failing the students. Students are therefore unable to realise their full potential".*
>
> (Page 789)

The blame for this is considered in the Howson et al (1995) report where the changes of emphasis within school mathematics away from 'core' algebraic techniques to 'open-ended' problem solving, statistical and investigational activities are identified, (Edwards, 1997). Fleming (2003) also highlights the reduction in traditional algebra and geometry as a weakness. The introduction of modular courses has also allowed students to leave out particular topic areas. This means a more varied topic base is being covered at secondary level, which does not match the pre-requisites of engineering courses.

Prior to Cockcroft, there had been several major national engineering curriculum studies in America, all of which impacted upon the engineering curriculum in the States. The main studies were Fletcher (1896), Magruder (1906), Mann (1918), Wickendon (1930), Hammond (1933), Hammond (1940), Hammond (1944), Grinter (1955), Walker (1968), Holloman (1975), Corcoran (1977) and Grayson (1977), all of which were mentioned in Griffith (1985). SEFI was the European answer to the next stage during the 1980's. This has meant a continual updating of the syllabus. So why is this? The engineering curriculum is constantly in a state of flux for a variety of reasons. The curriculum has to respond to changes in legislation, to advancing technological knowledge, to the general academic requirements of parent institutions, to pressing social issues (such as equal opportunities, occupational health and safety) and to a more varied student base. Otherwise it will become ossified – a viewpoint that is already being directed towards mathematics, Griffith (1985).

Along with changes to the syllabus, there have also been changes applied to the assessments of the knowledge gained. Cowan (1986) found that quantitative problems produce ‘correct’ solutions, but not necessarily understanding whereas qualitative problems cover the same concepts in a deeper, more rewarding way. If this is applied to Cowan’s simplified levels of cognitive ability (see Table 2.1), with Level 1 being the lowest, then quantitative problems usually meet Levels 1, 2 and 3. Only rarely do they meet Levels 4 and 5. Qualitative problems, however, are more likely to start with Level 4 and either lead to Level 5 or Level 3.

6	Evaluate
5	Synthesise
4	Analyse
3	Apply
2	Understand
1	Know

Table 2.1: Cowan’s Simplified Cognitive Levels (1986) Page 72.

This is re-iterated by Jackson (1994) who found that students were ‘learning’ to pass the next test, but not actually acquiring the necessary concepts to solve a range of tasks and problems. The emphasis placed on examination success and league tables is also seen as part of this problem (Gill, 1994).

Higher Education qualifications have traditionally been knowledge based. Assessment was built around formal examinations covering a part of a syllabus and needing a specific minimum percentage of correct answers in order to pass. Pressure has come from three separate bodies to alter this to an outcome led approach, (Battye and Challis, 1995). The three bodies are:

1 Employers – who require more suitably qualified and flexible employees.

2 Government – who set up the National Council of Vocational Qualifications.

3 Examination Award Bodies – who need to make their qualifications more meaningful and appropriate for the employers.

To succeed with outcome led qualifications competence must be demonstrated in all specified outcomes. This means knowing everything to a minimum level rather than a few topics in great depth. From a continuity viewpoint, this would be easier to work with, but this too has its drawbacks. At the extremes of the two assessment methods there is the student who only knows a couple of topics in very great depth as opposed to the student who knows very little about lots of topic areas, but both methods allow for the 'only knew it for the test' type student who now remembers nothing! There is also the issue of being unable to apply mathematics in context, especially as many students see little or no relationship between their mathematics and engineering, (Gill, 1994).

More recently, Fleming (2003) stated that engineering is a "*very visual discipline*" (Page 19). As a consequence of this, Fleming feels that thinking three dimensionally is essential. This requires a background of geometry, basic algebra and calculus together with connections, methodology and logical argument being less marginalized. This seems to be an echo of what has already been concluded in various reports since the mathematical problem was first announced. If a more up to date national report is looked at, the same theme crops up again!

The Smith report (2004) stated in conclusion: 0.36 that the second issue of major concern is

> *"the failure of the current curriculum, assessment and qualification framework … to meet the needs of many learners and to satisfy the requirements and expectations of employers and Higher Education institutions".* (Page 9)

His recommendation 4.4 echoes the need for confidence and familiarity with core skills.

> *"Recognition of the need to restore more time to the mathematics curriculum for the reinforcement of core skills, such as fluency in algebra and reasoning about geometrical properties".* (Page 86)

Looking at yet another more recent national report the worries about the syllabus are also echoed in the Tomlinson report on 14-19 Curriculum and Qualifications Reform (2004), para 33, where he quotes:

> *"Higher Education officers and employers complain that learners themselves are being held back by the lack of opportunity to demonstrate their full potential".*
> (Page 18)

The development of the new AS and A level specifications under Curriculum 2000 did little to help solve the problems. In many ways this actually added to the problem by increasing the workload for the students whilst at the same time restricting their access to re-sits, formulae, and calculators. Porkess, (2003) reports that *"the combined effect of all these changes can only be described as a disaster for mathematics",* (page 12). The overall result was for AS mathematics to have the highest failure rate in both 2001 and 2002, and the next to highest failure rate in 2003. The net result of this was a decrease in the take up of A level mathematics across the country as it was perceived to be too difficult to achieve the required grades for further educational progression. The statistical results of this are reported by Porkess, (2003).

Hobson and Rossiter, (2010) found that students from local colleges studying engineering courses were confident with statistics and mensuration, but lacked confidence with algebra, trigonometry and calculus. Calculus was cited as being awarded the lowest confidence level. This corresponded to the problem areas cited by ‘A’ level students who had studied mathematics; but both algebra and calculus had been reported as problematic prior to Cockroft’s (1982) report.

Graham (2002) found that teachers regarded AS specifications of the post 2000 curriculum as covering too much in too little time, with “inaccessible” examinations causing high failure rates. This links with Croft (2003), Lawson et al (2003) and Hall (2002) who all found that students were not prepared for university in numerical disciplines. This was true both nationally and internationally. This was found to impact upon their programmes of study (Hawkes and Savage, 2000; Tariq, 2002; and Hutton, 1998). This is particularly true for engineering programmes (Hawkes and Savage, 2000).

In order to support this, Atkins et al (2005) recommended continuing remedial support whilst the UK Mathematics Foundation (2005) recommend a return to *“former approaches of targeting and nurturing more able students”,* (page 15). However, Hoyles et al (2002) found that there was an increased need for mathematical skills at all levels despite more use of ICT. In March 2005 the two tier mathematics GCSE was announced by the QCA, in line with the recommendations of the Smith report (2004). This was followed in June 2006 by the setting up of National Centres for Excellence in Teaching of Mathematics (NCETM), a virtual resource, which is now available for use by the teaching community. By August 2006, there was evidence of significant increases in uptake of A level mathematics and particularly further mathematics (BBC, 2006).

However, Atkins et al (2008) are still reporting a problem with the mathematical knowledge of prospective university students. They mention Hawkes and Savage (2000) finding a serious decline in the mastery of basic mathematical skills, and Pyle (2002) finding many students not sufficiently prepared for university courses requiring numerical skills. The UK Mathematics Foundation (2005) regards a solution to the mathematics problem as vital for mathematics. Part of the solution has got to be to build confidence, and from this higher success. This matches with Parsons et al (2009) who found that better mathematically qualified students were more confident with mathematics and achieved greater success on engineering courses. They also found that the greater their levels of confidence in their own abilities the more positive effect there was on success.

Australia also reports similar problems with mathematics. There is an identification that there are insufficient qualified mathematics teachers, and as a consequence the students are poorly prepared, (Trounson, 2009). This means that students are only prepared for basic level mathematics, and this is leading to an *"undermining of the nation's skills base in engineering"* and is a problem that needs to be addressed urgently if the country is not to fall behind its competitors, (2GB, 2009). More recently, Slattery (2010) reported that *"mathematics education in Australia is in crisis"*. He found that whilst students take up of mathematics at university level in Australia had fallen by 15% during 2001 to 2007; in Britain there had been a rise by 67% during 2002 to 2006. He also found that they needed to attend “enabling” programmes to help them catch up with secondary school mathematics.

In 2009, the Qualifications and Curriculum Development Agency (QCDA) consulted on draft criteria for level 3 mathematics qualifications to follow on from the changes to level 2 being introduced in 2010. Their proposals would standardise AS and A2 units in A level mathematics, in line with other A level subjects, as well as allowing “stretch and challenge” and better linking of pure and applied content, without disrupting the teaching of further mathematics. Free standing mathematics qualifications would continue, enabling students to choose mathematics study applicable to their needs and to support other qualifications. This is yet another syllabus change, but will it have any long lasting improvement for the mathematics problem?

The changes of emphasis within syllabuses have affected the knowledge base, but does it really show that there is a problem? The problem is not a recent phenomenon, but one that has been ongoing sufficiently long enough for the belief in a problem to be inbred into sub-consciousness. If the viewpoint is taken that there will always be a problem of some description – whether real or imagined – then perhaps it is the suggested solutions that should be critically examined.

2.3 Use of Information Communication Technology

Technology has been heralded by many as the solution to all educational problems. Consequently, as technology has improved, so have the expectations of what it can deliver. As well as being a resource for all subjects and levels it is a complete subject area within its own right. External pressures are catapulting the use of ICT to the forefront. This section looks at the historical background to its use, how to design resources utilising its strengths and finally how to evaluate what it has achieved in terms of Laurillard's Conversational Framework, (2002).

2.3.1 Historical Background

Even in the 1980's technology, in the form of microcomputers, was mentioned as a valuable resource which was likely to benefit individual pupils. The Government had already set up a Micro-Electronics Educational Programme and Cockcroft (1982) Pages 118,120, paras 404, 406, 412 acknowledges that it is

> *"important that ready acceptance of technological innovation should be fully exploited".*
> (Page 118)

Engineering has clearly taken this viewpoint, as by 1993 Barry et al had reported that all engineering disciplines use computers regularly so professional engineers will need to be able to use software packages. Some will need to "*specify, write, amend and extend*" computer programs, (page 225).

Dearing (1996), para 1.2.3 also refers to the use of technology. It is clear from the wording of his paragraph that he believes technology is already being used effectively.

> *"Recommendations assume that the potential of ICT for enhancing the range, effectiveness and quality of teaching will continue to be harnessed".*
> (Page 4)

As A level papers which would take 3 hours by hand can be completed in 10 minutes using hand-held computers with built-in software (Coxhead, 1997), this view would seem reasonable, however, when Da Ponte et al (2002) conducted interviews with pre-service mathematics teachers, this was not really the case. Using computers produced a degree of anxiety, usually related to lack of knowledge in basic aspects of ICT. Also the important potential of computers was unknown to many of these pre-service mathematics teachers.

Dearing's rosy view seems to be carried into industry. Bascombe (1990) reports that industry expects graduates to be experienced in using and applying computer technology, often to a greater level than is feasible. In order to take up Dearing's recommendations £230 million of funding from Lottery funds was made available from April 1999 across the UK to help teachers to improve their use of ICT in teaching and learning. Eighty three percent of those eligible had signed up by December 2001, but the overall effect was unsatisfactory with sixty percent of secondary and fifty percent of primary schools failing to address issues relating to the quality of ICT use in the classrooms. Secondary school programmes stopped due to subject specific training materials not capturing the enthusiasm of the staff. (Office For Standards in Education (OFSTED) 2002).

This does not seem to mirror Cockcroft's "*ready acceptance of technological innovations*" nor Dearing's belief that ICT "*would continue to be harnessed*". OFSTED's conclusions that both the National Grid for Learning (NGfL) and New Opportunity Fund (NOF) initiatives provided positive contexts for development by giving a new impetus does not mean that they have been accepted willingly by teaching staff. However, the finding that teachers with access to a computer for planning and preparation were more likely to be successfully trained in ICT and to use it in the classroom, is not really very surprising.

Despite this, computer usage by many teachers is often only a result of syllabus requirements and not a matter of choice. Indeed, OFSTED (2002) make two opposing statements on page 4. "*There is now an unprecedented willingness in the teaching profession to embrace ICT*" and "*For many secondary teachers, the training materials do not sufficiently engage them or make them want to explore the application of ICT to their subject*".

So, is technology becoming the new mathematics problem, or is it a tool that can be used to help overcome the original mathematics problem? If the technology can be used in a way that it improves (or doesn't adversely affect) the learning experience, but helps the students to grasp essential concepts then it will be part of the solution. If the learners' experience is also looked at within this historical background, then it is clear that there is a driving force behind the use of technology, other than the fact that it may be useful. Collis et al (1997) discuss the special report from the Commission of the European Community Directorate General XIII in their experiences from the TeleScopia Project. There is an assumption that flexibility to meet the needs of the learner is paramount, (Van den Brande, 1993). Individual needs must be met by adaptation, varying media combinations and changing learning patterns and settings.

From one view point, this echoes the optimistic views of Darby from 1992 writing about the future of computers in teaching and learning, (Darby, 1992a). It was felt that the growth of high speed networking combined with electronic mail and conferencing systems that could support sound and graphics would enable learning remotely as well as on site. (The vision of e-learning was already emerging).

Wellington (2005) summarised the major initiatives behind the drive to promote ICT within education up to 2002. These are shown below in Table 2.2.

Time Frame	**Amount Spent**	**Initiative**
1980-1986	£32 million	Microelectronics in Education Programme
1981-1984	£16 million	Micros in Schools Scheme
1982		Information Technology Year
1983-1987	£240 million	Technical and Vocational Education Initiative
1985-1986	£3.5 million	Software Subsidy
1986	£1 million	Modem Scheme
1986-1988	£3 million set up, £5 million pa	Microelectronics Education Support Unit
1987-1993	£19 million	Education Support Grant
1992-1995	£10 million	Computers in Primary Schools
1996-1998	£10 million	Education Departments' Superhighways Initiative
1996-1998	£27 million	Laptops for Teachers Project
1998- …	£100 million 1st phase	National Grid for Learning established
1999-2002	£230 million	NOF training for teachers and librarians

Table 2.2: Major Initiatives Pushing ICT into Education (Wellington, 2005) P27

This shows the amounts of money behind these initiatives more clearly. However, despite all this money there had been little or no change during the fifteen years prior to the ImpaCT2 study (Becta, 2003). Teachers lacked confidence in using ICT, and it was not integrated fully into subject teaching. The reasons for this were still lack of time to become familiar with software, limited computer access, and minimal support from senior staff.

From another view point, as use of ICT is looked for by OFSTED as part of their education inspection process, together with a targeting for individualised learning in the grading of schools and colleges, the rosy views of Dearing are being actioned irrespective of choice; and to some, in a rather steam-roller like way.

2.3.2 Designing Resources

In order to address some of the mathematical problems, it may be possible to use some of the more beneficial aspects of ICT. One way of achieving this would be to provide electronic resources stored on a VLE. This would then allow 24/7 accessibility of tailor-made provision. A starting point would be to use the visual format of the PowerPoint slides as opposed to the more traditional Word–based text offering, and to integrate them with SMARTboard technologies. As a consequence the mathematics resources to be used in this research project are initially dependent upon pre-prepared PowerPoint slides, which can be edited and annotated as the lecture progresses. To make the slides as effective as possible it would seem sensible to draw upon the experiences of others in slide design and multimedia presentations.

Clarke (1995) researched designs of computer based learning material. It was found that the screen becomes the critical interface between the learner and the material. Thus, this display needs to be effective. The use of colour increases interest and motivation, but only up to a maximum of seven. More than seven colours are distracting and make the information difficult to understand.

Type of Graphic	Order	Individual Graphics
Representational	1	Realistic
	2	Cartoon
	3	Line drawing
Logical	4	Diagrams
	5	Charts and tables
Analogical	6	Analogies

Table 2.3: Illustration Type Preference (Clarke 1995)

The size of acceptable graphics seems to be variable according to the expertise of the user. Overall it is best to use between a quarter and a half of the screen, with a zoom function facility to make the image bigger if necessary. There is, however a definite preference for a particular type of graphic, as can be seen by the ranking of individual graphic types in Table 2.3.

The best graphics are representational with realistic being the best. It could be a photograph of the item, for instance. The worst graphics are analogical where a similar image is shown to imply a similarity.

Images are easier to extract information from than text only, but if the graphic is complex, not all of the information is extracted. Displays containing 4 part screen images were less effective than 3, 2 and full screen displays. Structured text was preferred to logical graphics, but analogical images were seen as realistic rather than as a link.

Cross referencing increases usage of additional modules cumulatively, but only up to a maximum of three. Accidental leaving of the system has to be catered for so that it is easy to get back into the same point in the information again. Sequential routes are usually chosen, following the order of the main menu, so this needs to be set up carefully. More experienced users are likely to browse rather than complete a module before moving on, so it may be necessary to include forced stops to prevent this, depending on how the material is being used. It could be by restricted date access to the material or by setting individual restrictions.

This last point agrees with Frau et al (1992) who found that the structure of the material affects the learning process. Rules are needed so that the order in which the material is accessed does not have an adverse effect on the students. Also, not really surprisingly, irrelevant items, such as extra text, sound and pictures reduce the effectiveness of presentations, (Reiber, 1996; Schraw, 1998; Moreno and Mayer 2000; Mayer 2001; Bartsch and Cobern 2003). However, Graham and Berry (1993) found that with a video presentation the use of a professional voice, such as a radio presenter, improved the video. The re-editing of the video after feedback was seen as worthwhile as the final version was better received.

Bartsch and Cobern (2003) report that Large et al (1996) found that text with an image, as opposed to just text, produced better problem solving but not better recall. The study was covering animation in descriptive and procedural texts. This is a result that was not expected. Walker and Graham (2000) found that both image and audio were important, but that video which was not directly related to the subject, such as the face of a tutor, was not.

Engineers are purported to be visual and the old catch phrase ‘a picture paints a thousand words’ would seem in opposition to the results of this study, with regards to recall. However, maybe by solving problems the recall is also improved. Also, personal observation of engineering students has shown them to prefer working with animations of ‘How Stuff Works’ from the associated web site over reading about the same topic. This may be a finding that is not appropriate to engineering students, or one that is limited to the particular American study groups of Large et al (1996) which are reported in Bartsch and Cobern (2003). Malabar (1997), only a year later, but with British counterparts as opposed to American, found that multimedia assists the creation and retention of mental images by its use of dynamic images rather than static ones. Also the pictorial and symbolic representations can be related more readily by the utilisation of the dynamic nature of the multimedia. Further studies quoted by Bartsch and Cobern (2003) seem to concur that graphics improve student recall. These studies are with more scientifically biased students of differing levels, (ChanLin, 1998; Lowry, 1999; ChanLin, 2000; Szaba and Hastings 2002).

Bartsch and Cobern (2003) conducted a study of using PowerPoint and transparencies. Initial ratings at the end of class did not show any preferences, but retrospectively PowerPoint was the preference. The students believed that they had learnt more from the PowerPoint than the transparencies both initially and retrospectively. West (1997), Cassidy (1998), Perry and Perry (1998) and Susskind and Gurien (1999) all support PowerPoint as a preference to transparencies. However, Stoloff (1995), West (1997), Susskind and Gurien (1999) and Szaba and Hastings (2002) all found that the use of multimedia presentations had not increased student performance whilst Bartlett et al (2000) even found that there was a decreased performance when students were switched from transparencies to PowerPoint.

All forms of media have an optimum use. Print is supposed to be best for reflection. Television and film are supposed to be best for action, three dimensions and simultaneous multiple events are best suited to scientific topic presentation. Computers can interact so that they allow communication with complex systems which have multiple and interacting variables, (Henderson and Landesman, 1991). For instance, Gladwin et al (1992) used Computer Assisted Learning (CAL) in teaching chemistry and found some useful benefits with this approach. CAL led to better coloured graphical displays, greater use of dynamic modes of instruction, more use of simulations and the ability to perform complex calculations quickly and vary the parameters.

Dubinsky (1991) felt that computers could be used to provide representations for many of the objects and processes from abstract mathematics which caused students problems, but Maull (1998) found that engineering students preferred verbal options in a mathematics context as opposed to diagrams in a mechanics context, despite being perceived as visual people.

Entwistle and Tait (1990) and Wilcoxson (1998) all report that engineering students preferred activities involving meaning and reproduction based approaches. As most learning environments for engineers tend to be reproduction based, this view is not unexpected. Dreyfus (1991) takes the view that the computer for the mathematician is the equivalent of a microscope for the biologist. If used correctly with interesting items an unexpected visual picture can result which leads to new ideas and the grasp of previously unknown relationships.

Reynolds et al (2003) point to ICT as an enhancement to extend conventional learning, but found that the lack of system reliability impacts negatively on students' attitude to its use. There is also the need to have regular accessibility to computers for them to become part of learning. Weerasinghe et al (2008) considered learning styles for online environments. Knowing students learning styles is important for both course design and delivery (Bostrom et al, 1990), and the effectiveness of any learning programme can depend upon this (Kim and Sonnenwald (2002). However, online learners have not been well researched (Valenta et al, 2001). Iriarte Diaz-Granados et al (2009) agree with Shih and Thompson (2000) and Sarkozi (2002) that the success of online students depends on more than just learning styles. They are also guided by *"intrinsic motives"*. The introduction of a web-based environment changes the behaviour of the students towards studying, rather than changing their learning styles.

As an overview, Forsyth's comment (1998) that:

> "*To present material on the Internet as a learning tool we should be incorporating all those features that optimise computer-based learning and reduce to a minimum those features that have already been identified as hindering learning through the use of computers.*"
>
> (Page 49)

is one that should be heeded.

2.3.3 "Conversational Framework"

Pask (1975) found that conversation theory predicts that matching learning styles to materials allows for sound progress to be made, whereas a mismatch of learning style to materials hinders progress. Laurillard (1987) and Barbour (1990) conclude that in order for matching to occur in real time the computer must be able to alter what it does to match what the user needs. So, how effective is the system going to be?

The best way of evaluating this would be to use Laurillard's (2002) Conversational Framework, see Figure 2.1. This is her set of requirements for any learning situation, so that the full cycle of all learning opportunities can take place.

The Conversational Framework is:

> "*intended to be applicable to any academic learning situation: to the full range of subject areas and types of topic.*"
>
> (Page 87)

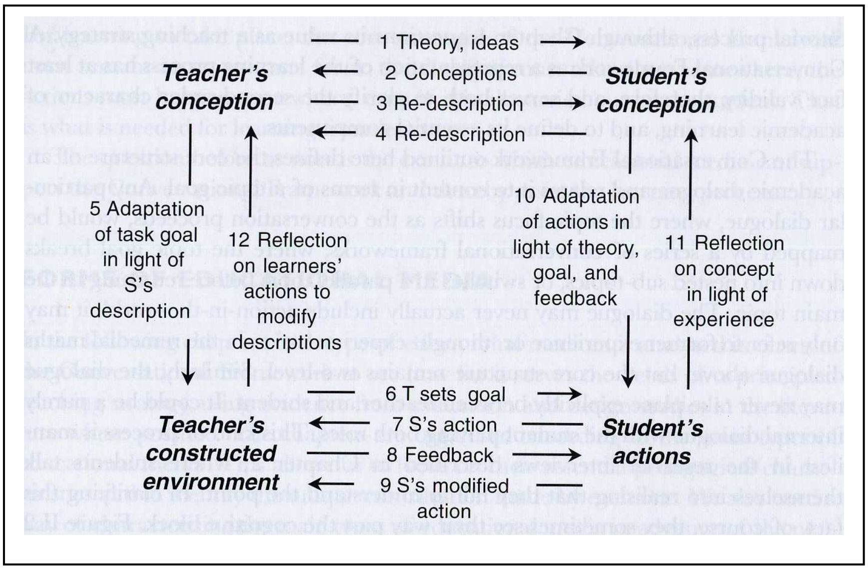

Fig. 2.1: Laurillard's Conversational Framework (2002) Page 87

Laurillard has reworded the Conversational Framework into twelve statements in order to evaluate the range of activities the various media can cover. These are shown in Table 2.4. According to Laurillard's definitions of media, a VLE has the effect of taking a narrative media and processing it into both interactive and communicative media. Narrative media are linear non-interactive media that cannot respond and it is up to the learner to understand them. Examples of this are print, audiocassette, television or film, video cassette and digital discs.

1	Teacher can describe conception
2	Student can describe conception
3	Teacher can redescribe in light of student's conception or action
4	Student can redescribe in light of teacher's conception or action
5	Teacher can adapt task goal in light of student's description or action
6	Teacher can set task goal
7	Student can act to achieve task goal
8	Teacher can set up world to give intrinsic feedback on actions
9	Student can modify action in light of feedback on action
10	Student can adapt actions in light of teacher's description or student's redescription
11	Student can reflect on interaction to modify redescription
12	Teacher can reflect on student's action to modify redescription

Table 2.4: Laurillard's Twelve Statements (2002) Page105

Interactive media are linear media delivered in an open, user-controlled environment. Interactive in this sense means able to navigate and select content at will. Examples of this are hypertext, hypermedia, multimedia resources, Web-based resources and Internet delivered television.

Communicative media take two different forms. These are synchronous in which communications take place by text, video or audio over a network at the same point in time and asynchronous in which the communications are accessed at different times. Communications can be by email, discussion forums, chat lines and audio.

Adaptive media are those in which the computer responds to the input of the user by giving feedback. This can be in simulations, virtual environments and educational games.

Productive media allow the student to create and produce a system of their own, designed to a specific end. Examples of this are microworlds, productive tools and modelling environments.

In summary,

- Narrative covers statements 1, 4, 6 and 7. (Page105)
- Interactive covers statements 7, 8 and 9. (Page124)
- Communicative covers statements 1, 2, 3, 4, 6 and 7. (Page160)
- The VLE should cover statements 1, 2, 3, 4, 6, 7, 8 and 9.
- Statements 5, 10, 11 and 12 would require adaptive media use of tutorial simulations together with productive media use of modelling environments. (Pages144 & 172)

There are eighteen key features that would be expected in a VLE, according to Laurillard (2002). This is based upon information from Britain and Liber (1999) and Ryan et al (2000). These are outlined in Table 2.5.

	Feature	Description
1	Noticeboard	Managed daily, updates, topical events
2	Course outline	Outline, schedule, critical dates, hyperlinks, home page to modules and content of course
3	Student's personal pages	Profile page visible to all users
4	Narrative media	Print and video also available by hard copy on request
5	Adaptive media	Hyperlink to taster and full downloads, also DVD/CG if too large to download because of modem speeds
6	Web resources	Reading list from web – resources, etc., - staff, library
7	Conferencing tools	Collaborative exchange (asynchronous) Small groups (synchronous)
8	Assessment formats	Diagnostic pre tests with interactive computer marking – multichoice, open ended, model interaction, simulation
9	Assignment handling	Automatic upload for students and marking/feedback from tutor. Marks recorded for student on system
10	Student notebook	Stored web page address linking materials and student work pages
11	Student contributions	Uploading of students materials by students into shared area
12	Bookmarking	Individuals can build up own list of favourites
13	Email	Email to tutors, peers and others in the organisation
14	Students home page	Progress page with all vital information and links to resources and institutional help centres
15	Navigation	Course homepage default – easy hierarchical structure
16	Metadata	Author, date, copyright, audience
17	Tutor support	Student progress and set targets. FAQ section. Monitoring access tool
18	Student support	Generic information for IAG cross college

Table 2.5: Key Features of a VLE

As the mathematics resources will be accessible via the internet through the VLE, the next area of interest is that of e-learning.

2.4 E-Learning

E-learning is the extension of using ICT to providing whole courses based on a computer. This section looks at the focus, learning styles and usage of e-learning. Typing in 'define: E-Learning' into the Google search engine comes up with a dozen examples. Within these examples there are several different definitions of e-learning, which can be grouped into different types of definition. These are paraphrased and synthesised by definition type.

Definition Type 1:

E-learning is something that can be accomplished over the Internet, a computer network, via CD-ROM, interactive TV, or satellite broadcast. (Geocities, 2005). It is self-paced, interactive training containing multimedia elements such as sound, video and animation and automated test questions that provide instant feedback. (Pit-magnus, 2005). Some form of interactivity is involved, which may be with teachers or peers. (Ministry of Education, 2004). This includes email, discussion forums, and collaborative software. Just-in-time learning is possible, specific needs can be met and asynchronous learning can take place. (Wikipedia, 2005).

- All these definitions highlight interactivity as a key feature of e-learning.

Definition Type 2:

This is any type of learning using computers, whether at a distance or face-to-face. (Usd, 2005). It can be referred to as web-based training, online learning, distributed learning, technology for learning (Marriott, 2005 and Schools, 2005), and it uses a network to provide education. (Onlinedegreezone, 2005 and Eduspecs, 2005).

- These definitions highlight computers as a key feature.

Definition Type 3:

This is the delivery of materials over the web by using specially created software (Websight, 2005), self-study material that is available electronically (Techscribe, 2005), and a transfer of skills and knowledge through network transfer. (Neiu, 2005).

- These definitions highlight electronic materials as a key feature.

Looking at all three definition types, then, it would appear that e-learning is a mixture of using electronic materials through computers with interaction of varying types taking place.

2.4.1 Focus

One question that still remains to be answered is that posed by Kaput in 1992:

> *"Will the technology help us to do better what we have been trying to do?"*
>
> (Page 548)

The first things that need to be considered are the strengths and weaknesses of the internet as a delivery option. These have been clearly itemised by Forsyth (1998), who states that the educational strengths are:

- Work can be undertaken at any time convenient to the learner, which increases motivation
- The computer does not get bored with testing and retesting
- The assessment is not seen as judgemental if poorly executed, because it is impersonal
- The structure of the materials is more professional
- Simulations save money and resources but give real world experiences
- Course segments provide variety, thereby possibly stimulating and promoting positive attitudes
- Central organisation means a controlled content with reporting, evaluation and record keeping facilitated
- Individualised instruction is possible by individual navigation
- Instant feedback is possible
- Readily available links to other sources of information
- Ability to send messages

and that the educational weaknesses are:

- Inappropriate material is used, i.e. electronic page-turning
- Interactivity requires active involvement from both the learner and teacher. This does not always happen

He also includes a technical weakness:

- The limitation of the computer, screen or operating system to cope with what is required.

(Pages 50-51).

Bishop et al (1992) envisage distribution of course packages to individuals and groups from several institutions over networks. Within these packages the use of multimedia elements will be significant in stressing both the applicability and relevance of mathematics. However, De Corte (1994) reports that computer based learning environments should create problems and simulations that can be solved, referring to Kintsch (1991), Scardamalia et al (1989) and Brown (1990). Mathematically this has led to a more supportive system which focuses on coaching and scaffolding rather than tutoring. It is more student-centred, less structured, less directive and more collaborative, (Kaput 1992). Powerful teaching-learning environments integrate the computer utilising its strengths of interaction and simulation, and have already been developed (De Corte et al 1992). There has also been discussion of co-operative learning with computers (Mevarech and Light 1992).

With initiatives to widen participation in higher education, but without an increase of resources, more efficient course delivery methods are needed. Gladwin et al (1991) suggest using information technology to do this. Inter-active video systems, compact disc and computer based learning would allow for more independent learning materials and bridging packages. This is now achievable due to the technological progression to sharing documents and applications through desk top computers. Added to this is the variety of synchronous and asynchronous two-way activity through satellite broadcast and now broadband internet technologies which allow simultaneous delivery of sound, video, graphics and data, (Collis et al, 1997). This is a view shared by Da Ponte et al (2002).

This method of e-learning is now seen by many as the way ahead, and is included in the College's ILT strategy, (Turner 2002).

> *"The provision of student accounts on the computer network will also allow access to Virtual Learning materials on the Blackboard Virtual Learning Environment. By 2005 it is expected that over 500 course modules will be available electronically. With individual student accounts, this material will be available for access from any Internet connected PC, at any time. This will not only provide added flexibility, but will also allow wider participation in learning for those students who cannot commit themselves to regular attendance in a classroom."*
>
> (Page11, paragraph 3.5)

This first statement shows that by 2005 e-learning in some form will be available for about 500 of the course modules. With one of the departments this strategy is taken a step further to include on-line video-streaming.

> *"Within the Technology and Computing department it is anticipated that the use of the VLE will increase and the use of web-based delivery will become much more common, using on-line video streaming technology.*"
>
> (Page16, paragraph 4.7.11)

Conole (2002) describes VLEs in some detail, and explains that there are three main applications for the VLE – supporting teaching and learning, administration, and storing information. Its major property is its potential to provide *"a holistic all encompassing platform"*, (page 10). VLEs are now frequently in use as gateways or portals to other resources, so are being adapted to suit user needs. Conole (2002), Britain and Liber (1999), and Armitage et al (2001), describe VLEs as systems which *"encourage active learning"*, *"shift from didactic to facilitative teaching"* or *"build online communities"*, (page 9). This is because they integrate communication and assessment tools with learning resources.

However, the introduction of e-learning has several implications. The focus of teacher and learner will have to change in light of the different techniques and accessibility that are required. Boyd et al (1991) make the point

> *"Students take responsibility for their own learning; the teacher is not the dispenser of knowledge. It becomes the student's responsibility to discover and internalise the material."*
>
> (Page 8)

As a consequence, it will be necessary for learners to increase their skills, namely being able to search and design enquiries, download material in order to work offline, use e-mail, use file transfers for test and assessment tasks and use file transfers for communication with fellow students and subject staff, (Forsyth, 1998).

It is interesting to note that even back in 1992, Kaput observed that:

> *"The same technological forces that shape the mathematics also deeply affect the teachability and learnability of mathematics, both new and old."*
>
> (Page 515)

Four years later, the Australian Association of Mathematics teachers (AAMT, 1996) refer to the fact that:

> *"The rapidly changing nature of computer technology continues to expand the range of resources available for mathematics learning."*
>
> (Page 3).

So, Kaput's view, slightly adapted, is still true four years later. From a technology stance this is remarkable since computers have upgraded very quickly. Some of the earlier computing and technology pioneers had visions which are only just starting to come to fruition.

The AAMT (1996) also comment that to realise the full potential of educational technology requires imagination, flexibility and the willingness of staff to update and change their view of both teaching and learning. Conole (2004), and Squires et al (2000), found that earlier research work focused particularly on multimedia applications and software navigation, but that the technology is actually transforming the way institutions work in terms of administration, teaching and learning, and research, (Beetham and Conole, 2001 and Beetham et al, 2001). The rationale behind this transformation is not fully understood, but is dependent upon the approach of the senior management team, (Littlejohn, 2003 and Nicole and Coen, 2003). Many institutions have not considered the pedagogy of the VLE approach, nor the implications for staff development; and are only considering the possible cost effectiveness of the approach. If they are to be part of the solution to the mathematics problem, then it will be necessary to keep pace with the emerging technologies too – such as mobile, smart and wireless.

In terms of e-learning products, Zemsky and Massey (2004) have found that course management systems such as Blackboard and WebCT, together with PowerPoint lectures have been the most successful market leaders. These technologies focus on distributing materials rather than actual teaching. E-learning was hindered at the start by low bandwidth and the lack of accessible broadband connections, together with both staff and students' lack of computer access. This has been addressed by huge investments, but the learning objects being used vary greatly. There is the potential to be "design-rich, delivery anytime, anywhere and fully customisable", but there is still a need to engage with the technologies more interactively for them to be specifically suited to each individual's preferred learning style. Taking these views to the extreme does mean that e-learning will be part of the solution to the mathematics problem.

2.4.2 Usage

There are e-learning environments and internet resources available already, but are they used? Asp and McCrae (1999) report that mathematics teachers in Australia and Becker's equivalent studies in the USA (Becker 1999) made little use of internet based activities. However, an intervention study using TopClass, a web-based conferencing tool, was undertaken by Foley and Schuck (1998a, 1998b) and Schuck and Foley (1998). They found that although group collaboration was regarded as valuable there were problems with accessing and using the technology. These problems are reported frequently and Da Ponte et al (2002) regard this as a "*major limitation*" in the success of e-learning and computer-based materials.

The internet is a key source of information – particularly for mathematics, which is one of the largest subject areas. The drawback is being able to find exactly what you need at the appropriate level and addressed in a way that it makes sense to the individual searching for the information. Access is becoming less expensive and new software enables fully interactive lessons tailored to individual students to be delivered quickly, cheaply and possibly more enjoyably, (Cahn, 1998).

It is important that time is given within the environment to read and interpret what is viewed. If mathematical understanding is to be encouraged then meaningless button pressing activities have to be avoided, (Weigand, 1999), but by including interaction the learning can be enhanced, (Sullivan and Mousley, 1996 and Asp and McCrae, 1999).

Abouserie et al (1992) found that there was a preference for CAL support and as an addition to usual instructional methods, but not as a substitute. When Pitcher et al (2002) investigated computer-based learning packages they found they were used ‘more’ or ‘much more’ when a test was imminent. Those who regarded it as most useful were those students who had not felt confident about their success with paper-based testing. In both of these cases the material was used supportively by the students, as an addition to the usual lecture. It was used to reinforce and extend knowledge already gained from the lecture and to self test knowledge by completing quizzes and self test modules.

OFSTED (2002) reported that teachers using distance learning materials in their own time did not progress as well as when the NOF training was actively supported. If this is true of the teacher, then it surely must be the same for their students, but Darby (1992b) attributes the multimedia workstation with a capability of delivering an “*intensely supportive environment*”. He also believes that computer literacy will automatically improve as a by product of using an e-learning environment. This supports the findings of both Abouserie et al (1992) and Pitcher et al (2002). The computer based material is not sufficient in itself, there needs to be some further backup – be it lecture based, tutorial or interactive feedback.

Powell et al (2003) have further adapted Scribbins and Powell's (2002) concept of an e-learning fan, which demonstrates how the seven different areas of e-learning can work together to provide a full experience. Each of them can be used in different situations to develop teaching and learning to suit student's needs. Moving from one side of the fan to the other allows greater autonomy for students, and the amount of ICT involved varies between each of the segments. As the autonomy of the student increases, there is more reliance on unsupported use of ICT. This also matches the changes from traditional teaching right through to remote learning. The individual segments show what needs to be in place for each of the different forms to be effective. This can be seen in Figure 2.2.

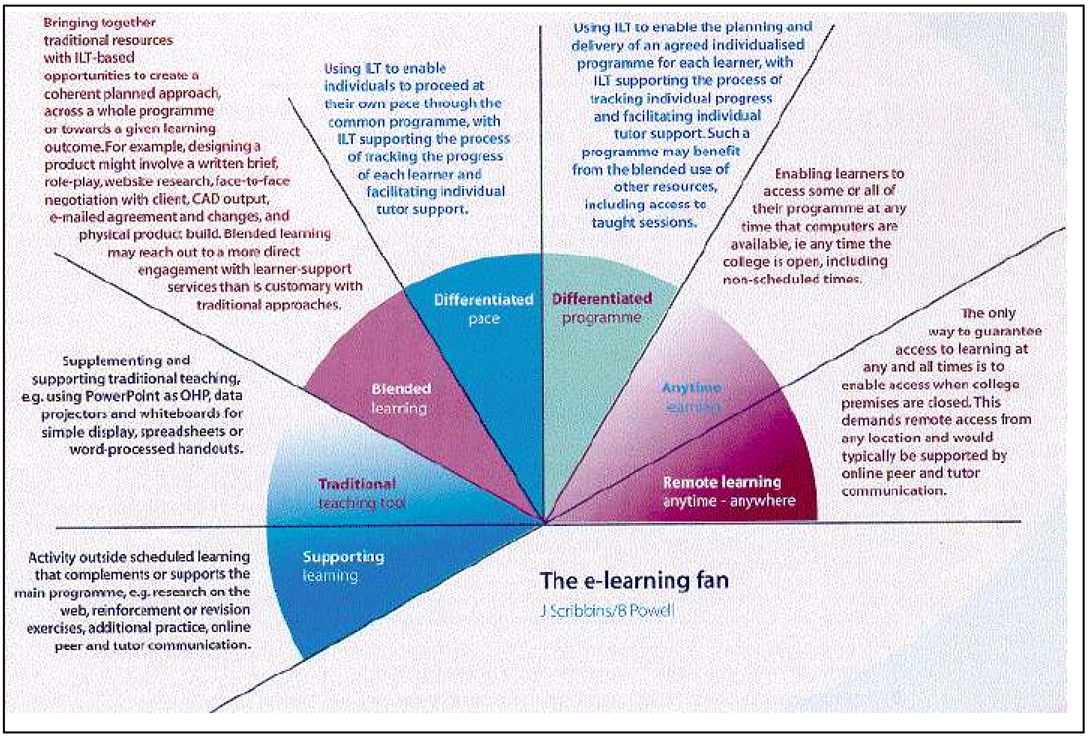

Figure 2.2: E-learning Fan

From a professional delivery view, Jesshope (2001) compares two approaches used by Tegrity Systems and AudioGraph. The former captures a live class presentation whilst the latter is created in the teacher's own time. The belief is that the latter will produce a more polished outcome. If it is polish that is required, then Tegrity Systems can be used without a class in a similar way.

However, if the student would normally be part of the class, then the added input would make the presentation unique to them and their group. Each group would then have their own personalised set of lectures available for reviewing, or taking part in along with the rest of their group. This would make the material more personalised for the student. As the material is not for presentation to a world audience, but specifically aimed at the students and their individual groups, this extra polish is not really an issue that is important here, unless the one presentation is used for all the groups. By being more individualised, the students are more likely to take ownership of the material. Sometimes a presentation can be too slick and too clinical and as a consequence its meaning is lost on the people it is intended for because they cannot engage with it on a personal level.

As far as the College is concerned, staff are expected to develop online materials and students will be required to be able to use the technology to access them, (Turner, 2002).

Thompson (2009) reports the FE minister's ambition to see the FE sector recognised nationally and internationally for its commitment to technology, as well as for the innovative and creative ways it uses technology. Talks with

Becta and others about how to support more and better examples of the investment in technology are already underway.

2.5 Suggested Solutions

Having looked at the problems, the possible solutions that have been suggested to date are next considered. These are divided into the three main areas that were discussed earlier, i.e. mathematics, ICT and e-learning.

2.5.1 Mathematics

In order to solve the problem, there are several issues that need to be covered. The first is a content issue – what is needed, at what level, and to what depth? This is an area that will change according to engineering developments, so cannot be categorically specified. It can only be regarded as a 'snapshot' item – i.e. what we need at the moment.

The second issue relates to the perception, difficulty and relevance of mathematics. This is the easier issue to resolve, in theory, and there are recurring themes in the solutions. The third issue relates to the learning environment experienced by the students.

Hall (1993), Jackson (1994) and Fuller (1994) look at the requirements of external organisations. For them the mathematics has to be related to both HE requirements and how a professional engineer would use the subject at work. The engineering must also show that it is needed by both industry and commerce by being relevant to real world scenarios. To accomplish this improved co-operation between engineers and mathematicians is needed.

Practice at solving open ended problems within an engineering context is seen as the way forward by Howes (1988), Cox et al (1995) and Kent (2002). The engineering objectives need to be integrated so that the mathematics is seen to be useful, although it is not necessary to cover everything in equal depth. Computer software and group work can help with this so that tedious number crunching can be eliminated in favour of the mathematics concepts and collaboration can provide confidence in application of these concepts.

A similar view is taken by Barry and Steele (1993), Botham and Crowe (1997) and Maull (1998), although they are more specific in looking at mathematical modelling rather than just open ended problems.

The ability both to understand and apply mathematics to solve modelling problems is what is required. This helps to develop concepts and understanding. It allows for learning mathematics at different levels, but can also be used to assess these levels. It is a vital part of engineering.
Arising from these views of open ended problems and modelling is the idea that the theory needs to be contextualised and linked to the real world. An integrated approach, delivered in a more exciting way will enable greater linking of concepts, thereby improving problem solving skills and progressing towards more advanced mathematical thinking, (Greene, 1992; Curran and Middleton, 1995; Dreyfus, 1991 and Townend, 2001).

There are several ways of bringing the concepts to life. Underwood (1997) prefers "*efficient representations*" (page 3), which makes natural constraints clear so that it is easier to select the necessary information. Malabar (1997) and Dreyfus (1991) both refer to visualisation – a view that has frequently occurred elsewhere in the literature. Dreyfus (1991) cites Kautschitch (1988) as having found that "*dynamic visual sequences*" were good for abstraction. This agrees with Jackson (1994) who sees graphics and animations as a way to show 'hidden' items and Henderson and Landesman (1991) who used video representations of real world examples. Crowther et al (1997) and Maull (1998) also agree that three dimensional, practical and visual applications help to give meaning to mathematical concepts within engineering.

From a learning environment viewpoint, Jackson (1994) suggests a workshop as a complement to the usual program of tutorials and lectures. She outlines three different types of workshop – group problem solving; individual predict, observe, explain; and group concept mapping. Group problem solving is where the students work collaboratively in threes or fours to solve given problems. Individual predict, observe, explain is where individuals give their predictions for the outcomes to a particular problem, they then observe the modelling of that problem and explain how their predictions fit (or not) with the real situation. Group concept mapping is where the students work collaboratively in threes and fours to "mind map" processes, procedures and proofs to solve problems. It is a different working environment and can provide an enjoyable alternative. Burton (1997) suggests incorporating assessments into the learning environment rather than concentrating so heavily on traditional examinations. Time for reflection and efficient, quick feedback on progress is necessary. Samuels (2007) and Deaney et al (2006) still cite mathematics lecturers' attitudes towards mathematics teaching methods and new technologies as being a greater barrier to change than the availability of the technologies, resources and effective teaching methods. The survey of mathematics teachers showed that although they had the technology provided, and were expected to utilise it, there was a resistance to change. Fear of being less knowledgeable than their students was seen as a major reason for not embracing the technology, along with the time required to change what and how they taught. It was regarded by many as an onerous and needless task. (Deaney et al, 2006).

ICT can be used for the visualisation and dynamic sequencing. The solutions for this are looked at in section 2.5.2, while the solution for the learning environment is addressed in section 2.5.3.

2.5.2 Information Communication Technology

Computers provide a different learning environment from usual lectures. This difference adds to the understanding of mathematics as students become responsible for their own learning. (Boyd et al, 1991). The computer based approach is one that is preferred by many students as demonstration software brings materials to life, (Curran and Middleton, 1995). The materials can be adapted for particular groups and selectively accessed by students from different interest areas, (Bishop et al, 1992). The Broadband service connection has improved accessibility (OFSTED, 2002) and together with new software has allowed learning to be asynchronous and synchronous, (Cahn, 1998).

Numerical analysis and symbolic processing packages can reduce repetitive manipulation of numbers, much of which is needed in engineering (Mackie and Scott, 1988 and Jackson, 1994). Using mathematical packages makes particular topics enjoyable and more interesting (Malabar, 1997), and students are more likely to persist with solving problems and take more risks when using technological tools. (AAMT, 1996). OFSTED (2002) report that spreadsheets are making a positive contribution to mathematics achievement and that data handling facilities and graph plotting software need to be utilised.

The computer can act as an extension to the mathematics teacher (Mackie and Scott, 1988) by using it interactively as a strength, (Kaput, 1992). The ICT allows a different approach to the mathematics to make the application clearer, (Da Ponte et al, 2002). With ICS the mathematics can be more easily recognised within an engineering context, (Townend, 2001) and CAL allows for a more efficient way of learning. This is particularly useful for engineering which has seen a substantial increase in background information as the discipline has grown, (Darby, 1992b). If the principles of successful computer games (i.e. being interactive and participative) are applied, this is like the problem solving modelling, (Huntley, 1995).

Dahler (2009) and Rishi (2007) both cite convenience and comfort as key factors to forms of successful learning. This arose from comparing the use of web applets to the use of a cellular phone to learn mathematics. The preferred solution (cellular phone) fitted best with student's *"mobile lifestyle"*.

By 2012, Becta wants 80% of FE providers (rather than the present 35%) to have reached "mature technology use". Their "Next Generation Learning Report" (2010) details an increase in learner satisfaction (50% to 99%) where technology is used effectively. However, IT is expensive, the technology is still evolving, and it can be difficult to keep pace. Every classroom needs an interactive whiteboard, a fast broadband connection, VLE access, email access and mobile devices to be on track. New students in September 2010 who have come straight from school will have been brought up using mobile phones, and they are more likely to associate the word ‘blackboard’ with VLE systems than its original meaning, Furness (2010).

But, ‘Sheila’s blog’ on JISC Cetis (Centre for Educational Technology and Interoperability Standards) (MacNeill, 2009) reports that *“there seems to be quite a bit of moving from Blackboard to Moodle”* as UK institutions review their technology provision and are migrating from proprietary systems to open source platforms.

2.5.3 E-Learning

There are several ways in which the solution can be found within the e-learning environment. Darby (1992b) mentions that as there may not be a “*human expert*” to ask questions in this kind of environment, then it is important to compensate for this within the materials.

Mackie and Scott (1988) emphasise appropriately designed packages which include computer based demonstrations. This not only encourages investigative work and problem solving, it helps with underlying mathematical concepts.

As the accessibility of the materials is dependent upon both the ability of the learners to use the system, and the way in which the materials have been structured on the system then an understanding of both the system and the interface is necessary before using the materials for learning, (Forsyth, 1998 and Frau et al, 1992).

Timmis et al (2004) found that much of the evaluation and support for VLEs has focussed on staff rather than learners, which agrees with Stiles (2002) who found that *"ease of use by staff"* was the main reason for selecting VLEs. There is now some recognition that VLEs support learning rather than provide efficiency gains (Brown and Jenkins, 2003). The motivation of the students is the major factor in the success of the implementation, (Cook and Timmis, 2002), but it is also recognised that the emphasis of the delivery through the medium of VLEs has to be different from the traditional information and transmission approach to teaching, (Prosser and Trigwell, 1999; Goodyear, 2001; Jones, 1999 and Armitage and O'Leary, 2003). There is the likelihood that the students will be more likely to move from *"passive consumers"* to *"constructors of their own knowledge"*, according to Goodyear, (2001).

The flexibility of this approach meets specialist training needs for private companies (Walker and Graham, 2000) and consequently a student could spend the time they want (or need) to spend looking at the materials.

Becta (2004) reported that the FE sector, taken as a whole, has a *"robust ICT infrastructure"* and they consider this to be capable of delivering a *"wide range of mediated learning experiences"*. Whilst ICT access has reached the levels set by the National Learning Network, there is still a growing demand, and the use of VLEs is increasing. These are found to be the easiest of the learning platforms to use, but are not yet extensively used across colleges, and neither are electronic learning materials. Where this is used it is mainly for additional support activities to extend independent learning, rather than for classroom teaching, although there is some blended learning taking place and innovations are beginning to spread throughout the FE sector.

This has progressed further and the government e-strategy requires that by spring 2008 every pupil should have access to an online learning space with the potential to support an e-portfolio, and by 2010 every school should have integrated learning and management systems, (Kenny, 2010). The 'Harnessing Technology Funding 2009 -10' (Becta 2009) survey found that large proportions of teachers were not fully aware of VLEs or their potential for supporting teaching and learning, whilst they have already been cited as transforming teaching and learning in a fundamental way (Kenny, 2010). His report confirms that using the management team to drive the introduction of a VLE is more successful than using the ICT department, and that involving students from the start is more likely to be successful than not using them. However, the students preferred platforms that mimicked social networks to those that were just repositories for staff work.

The VLE provision is now undergoing its next change of direction. Originally there was the concept of the MLE. This has now moved onto the PLE (Personalised Learning Environment), and there are now five models emerging which can address this, according to JISC, (2010). The models are:

1 one system in the clouds, many outlets,
2 plug-ins to existing VLEs,
3 many widgets from the web into a widget container,
4 many providers and many clients,
5 both a provider and a client.

The College system is following model two to expand its functionality.

The ideal approach is the one outlined by Romiszowski (1986), which he labelled the "*cybernetic*" approach:

> "*which attempts to set up an interactive system, adaptive to the student's needs in an on-line manner, based on what the system has learned concerning the student's needs, learning styles, difficulties, etc*."
> (Page 24)

This approach relies on having information about existing learning styles and habits, general interests and skills, and prior knowledge and performance.

Gill (1999) confirms that there isn't a single mathematics problem, so the solution also has to be multi-faceted. The problems identified during the 1990's were still only marginally different from those of over 25 years ago, despite a range of solutions having been tried. Perhaps each solution has only tackled a part of the problem, which has then highlighted other problems in an ongoing way – much like using a colander to hold water. Unless all the holes are filled the water still runs out, but *all* the holes have to be filled at the *same time* for no loss to occur! This, together with the concept of there 'always being a problem' leads to the question, in the future, can this be reversed? Perhaps the first steps are being made in television advertising (O_2, 2004) – associating being "*good at maths*" with having a particular mobile phone contract which saves money. Maybe in time, being good at mathematics will be regarded as the sensible (rather than peculiar!) option.

Learning Technologies (2010) suggests that the top ten predictions for 2010 are:

- More focus on delivery business value
- Web conferencing for live online sessions
- A continued rise in rapid e-learning solutions
- Increase in mobile learning
- More flexible learning management platforms

- Frameworks for social learning
- Scenario based learning
- More focus on building learning and development skills
- Learning and development will become more demanding
- More political will to see change in learning provision from the public purse

By harnessing the opportunities that Learning Technologies predict, it may well be possible to provide part of the answer to the ongoing mathematics problem. This is the area that needs to be researched in detail, in order to see if the use of a VLE enhances the students' learning of mathematics.

2.6 Summary

This chapter has described the background to the mathematics problem, and the various changes that have occurred both nationally and within engineering to various syllabi. It has also looked at the emergence of ICT and the directives bound up with this which have led to designing resources and providing interactive and student led learning through a variety of means, and considered how these might impact upon the problem, and how they could be evaluated using a "conversational framework". This then led on to e-learning - its focus, associated learning styles and general usage. Within this the role of VLEs was considered in some depth, as well as the implications of various government initiatives. Finally the suggested solutions to date were also examined and how the could be related to using ICT and VLEs were explored.

CHAPTER 3

THE COLLEGE, THE STUDENTS AND THE COURSES

3.1 Introduction

The research has arisen naturally from concerns related to the mathematical education and expertise of engineering students following academic courses at the College. This linked with the college's desire to embrace specific technologies which are compatible within a Managed Learning Environment (MLE), such as online learning through Blackboard Version 6, which is a virtual learning environment (VLE). This chapter describes the backgrounds of the college, the various students studying engineering mathematics and the changes applicable to their mathematics qualification under the new syllabi. It also compares other equivalent qualifications as well as giving the rationale behind the use of the VLE for the engineering students.

3.2 The College

The College can trace its history back to 1887. As well as being a well-established government-funded institution within the South West region, it is also the seventeenth largest further education college in the United Kingdom offering a broad range of education and training courses. The main educational technologies used within the College are IT, computers, projectors, student voting systems, telecom systems, and electronics and network labs, at both low and high levels. At the forefront of these is the virtual learning environment. This VLE can be used as a receptacle for documents, the main source of all the material, a means to assess courses, and as a source of lessons including pod casts, wikis and video clips.

The majority of students see it as a useful tool, and this has convinced more lecturers to utilise the VLE. This, combined with the push from OFSTED to include Information Learning Technologies (ILT) in lessons and the direct linking of graded lesson observations to the use of the VLE either within the lesson or for materials, has forced many reluctant staff into using the system. The more the system is used the more benefits it produces as it becomes an integral part of the teaching and learning expectation. It is becoming an invaluable tool to those who use it, and it has many advantages as it can be accessed from a variety of places.

The VLE at the College is part of an MLE, which includes the whole range of information systems and processes which contribute to learning and the management of learning. The Joint Information Services Committee (JISC) (2002) MLE Steering Group refers to VLEs as the

> "*components in which learners and tutors participate in "online" interactions of various kinds, including online learning".*
>
> (Page 1).

The connection between the VLE and the MLE, as detailed in the JISC (2002) Briefing Paper is shown in Figure 3.1.

The VLE links to other administrative systems, such as Instructional Management Systems (IMS). It enables online communications between the learner, tutor and other learning support specialists as well as peer-group communications. Online learning is supported, with learning resources, assessment and guidance available. The learning resources can be bought in or produced by the College staff. The students' activity and achievement can be tracked against a controlled access to the curriculum.

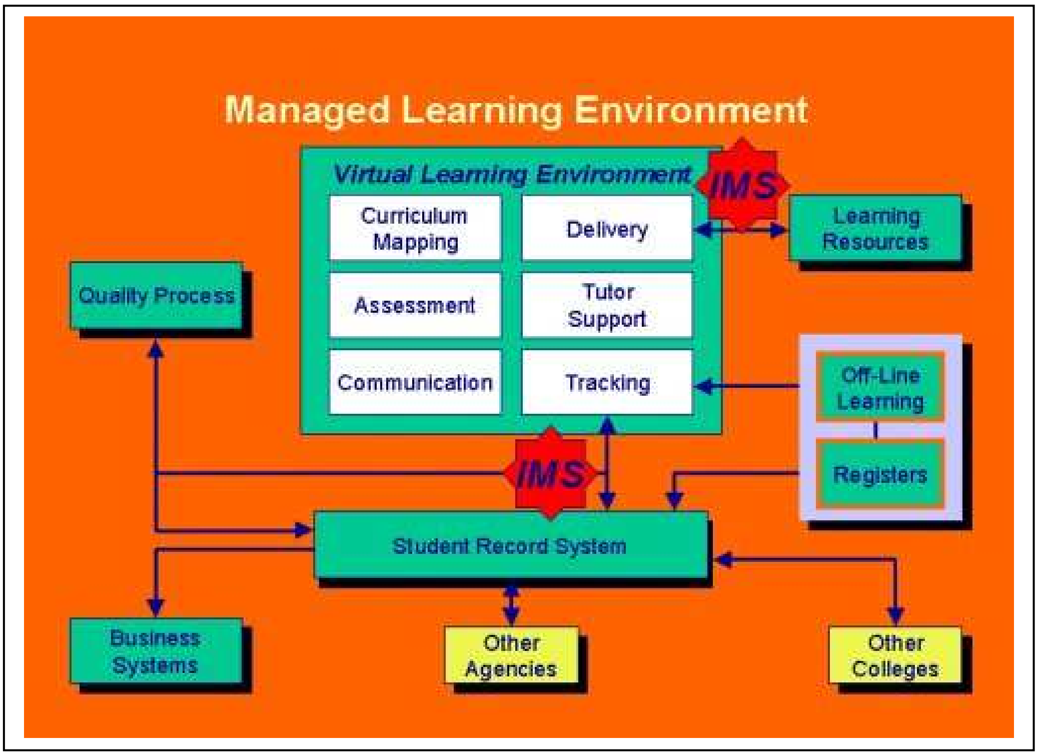

Figure 3.1: The VLE as a Subsystem within the College MLE

The College Information and Learning Technology (ILT) Strategy for 2002/5 states

> "*The use of ILT will increasingly become a requirement of course participation as staff develop the use of online materials, and expect students to be able to access them".*
>
> (Para. 3.1, page 8)

There are several reasons behind the increased use of ILT. The main drivers are external forces such as the government and employers, whilst internal drivers are the students and management staff. The government drivers are due to revised standards through both FENTO and OFSTED. Both of these bodies expect and require use of ILT as standard practice. Several employers send staff, who are also part-time students, away to remote areas of the country, but don't want them to fall behind with College work whilst away. It is also a very cost effective way of providing information to a large audience, which may not necessarily be on the College campus. This links well with management staff wishing to offer e-learning, etc., and looking at a broader regional intake, which can be offered much more cost effectively through a VLE than through the traditional taught lecture. It is more sustainable than providing multi-page handouts and leads towards the ideal of a paperless office. The down side for staff is that it is also much more visible and production of the materials in the initial stages can be very time consuming. A typical resource can take up to 6 hours to produce, and is only for one class session. However, once it is produced, it can be tweaked and updated with minimal time and effort, as necessary.

Engineering students are assigned to one of two departmental areas – Engineering or Technology. All of the groups follow vocational courses that are related to engineering, but the 'Engineering' groups follow practical vocational courses, where there are mainly practical units, such as welding, whereas the 'Technology' groups follow more academic vocational courses where there are mainly written units with only a couple of practical units, such as robotics. It is the students within the Technology group, following academic vocational courses with which this study is concerned, and in particular, those following National level courses (level 3), which are equivalent in status to studying 2 or 3 A levels. There are traditionally very few female students within this group.

3.3 The Engineering Students

There are three main categories of students:

- Full Time Diploma students

- Part Time Day Release Certificate students
- Part Time Block Release Certificate students

The differences between certificate and diploma are explained later in this chapter.

The full time diploma students have a perceived target of full time Higher Education. They are mainly 16 – 19 year olds who have recently left school with GCSEs or equivalent qualifications.

The part time day release certificate students are sent by their employers to upgrade their qualifications. They are mainly sent from engineering companies within Devon and Cornwall, such as Rittel, BAe Systems, DML (Devonport Management Limited) and Imerys. They have a range of ages and a variety of backgrounds and qualifications. They usually have GCSEs, A levels or other qualifications. If they do not posses any formal qualifications they have to pass the College entrance tests. They have not necessarily just left school.

The part time block release students are also sent by their employers to upgrade their qualifications, but with specific promotion posts in mind. They too have a range of ages and a variety of qualifications ranging from GCSE through to A level or equivalent. All of these students are employed in a support capacity to the armed forces. They have not recently left school as they have to have been working for their employer for a period of time to be eligible for the promotion posts. They attend College for two terms, terms 1 and 3, and cover the full 2 year course in the two blocks. They are in full time work at all other times, and often have to take some of the College work away with them whilst they are on duty possibly at sea or in other remote locations.

Even though each of the groups is taught separately, there is a diversity of mathematical expertise, backgrounds and experience within the teaching groups. Whilst the majority of UK full time students have recently left school with GCSEs at age 16, with mathematics grades of D and above, the same cannot be said of the part-time students. The part-time groups frequently contain a mixture of students with GCSEs, some with A levels (not necessarily mathematical in nature) and mature students who may have no formal qualifications at all.

3.3.1 Entry Qualifications

"Access & Recruitment onto revised BTEC Nationals" outlines Edexcel's (2003) policy for its qualifications. For entry to a National Level qualification a profile which shows "*the ability to progress on to a level 3 qualification*" is necessary. This is summarised in Table 3.1 where both Edexcel's National Engineering courses requirements and the College's subject specific requirements are noted.

EDEXCEL	**COLLEGE (SPECIFIC TO TECHNOLOGY & COMPUTING COURSES)**
Learners recently in education, profile to include one of: • A BTEC First qualification in the same or a related vocational area • An Intermediate GNVQ in an appropriate vocational area • At least four GCSEs at grades A* - C including Mathematics	Learners recently in education, as for Edexcel, plus: • Four GCSEs at grades A* - C to include English
More mature learners, profile to include: Experience of paid/unpaid employment	More mature learners, profile to include: Pass at College Entrance Test at appropriate level
COURSE TEAM VARIATIONS Individuals not meeting the above requirements can be admitted to the course at the discretion of the course team, if it is felt that they are likely to succeed in obtaining the qualification.	

Table 3.1: Entrance Qualifications Overview

The National Diploma is a level 3 course, i.e the same level as A levels (see Figure 3.2 NQF). This means that to study on the course students should have achieved at level 2, i.e the same as at least four GCSE grades A*-C; but many may have qualifications which match more appropriately to level 1, i.e. less than four GCSE grades A* - C or with a profile of GCSE grades G-D.

The Edexcel Qualifications Framework

NQF level	Academic Awards	General vocational awards	Key and Basic Skills	Short Courses	Specialist vocational qualifications	Occupational qualifications
5			Key Skills Level 5	BTEC Advanced Professional		NVQ Level 5
4			Key Skills Level 4	BTEC Professional	BTEC Foundation Degrees BTEC Higher National Diploma and Certificate	NVQ Level 4
3	AS & Advanced GCE	Vocational A/AS Levels	Key Skills Level 3	BTEC Advanced	BTEC National Diploma, Certificate and Award	NVQ Level 3
2	GCSE (grades A* - C)	Intermediate GNVQ Vocational GCSE (grades A*-C)	Key Skills Level 2 Adult Basic Skills	BTEC Intermediate	BTEC First Diploma and Certificate	NVQ Level 2
1	GCSE (grades D-G)	Foundation GNVQ Vocational GCSE (grades D-G)	Key Skills Level 1 Adult Basic Skills	BTEC Foundation	BTEC Introductory Diploma and Certificate	NVQ Level 1
ENTRY	Entry Level Certificates	Entry Level Certificates in Skills for Working Life and Life Skills	Adult Basic Skills			

The Edexcel Qualifications Framework – Authorised by Michael Hewens – December 2003

Figure 3.2: National Qualifications Framework (Edexcel 2003, Page 1)

3.4 The Courses

The vocational academic engineering students are split into several main disciplines, such as Mechanical, Manufacturing, Electrical/Electronic, Operations/Maintenance, and Telecommunications. They all follow a common core of six units, one of which is Mathematics for Technicians and a further six or twelve units, which have been designated by the course team from the engineering course specifications.

Dearing (1996) recommendations were finally implemented by the Qualifications and Curriculum Authority (QCA) when the National Qualifications Framework (NQF) was agreed and linked all the varying types of qualifications by levels. The National level courses are all at level 3. The NQF was shown earlier in Figure 3.2.

The students successfully completing a 12 unit course gain a National Certificate in their chosen engineering field, which is equivalent to two GCEs or the full Advanced Vocational Certificate of Education (AVCE) award, whereas the students successfully completing an 18 unit course gain a National Diploma in their chosen engineering field, which is equivalent to three GCEs. The National Diploma is recommended principally for 16 – 19 year olds who, having already decided on their work interest, can either prepare for employment within the sector or progress to a degree or other form of higher educational study in this area.

Both qualifications are aimed at providing a

> *"specialist work-related programme of study that covers the key knowledge and practical skills required within the sector"*,

but the Diploma

> *"extends and deepens the specialist focus"*.
>
> (Edexcel 2002, pages 1-2)

3.5 Syllabus Changes

In 2002 there was a significant change to the mathematics syllabus when the BTEC awards were changed. This was as a consequence of the National Qualification Framework set up by QCA to standardise the qualifications of different examining boards. The changes also seemed to reflect the European Engineering Standards for mathematical knowledge at the various levels, as reported in Barry (1995).

Looking at the SEFI Core Curriculum, Core Zero relates to the level prior to university. This is the A level, or National level 3 equivalent as expressed by the international committee who investigated what was required of future engineers. The curriculum was broken down into five different areas and the contents of these five areas are reflected in the syllabi of both the present A level in the Core Mathematics modules and the National level 3 equivalent core mathematics unit, Mathematics for Technicians.

Although the qualifications are different in the way that they are assessed and the syllabi contain different areas of study within these topic areas, their equivalence is clear at this core level. This linked in well with Dearing (1996) who wanted to be able to compare qualifications more readily, and also to enable easier progression to higher levels by having a more recognisable equivalence between the qualifications. Thus, by providing a common framework for the qualifications, progression to higher levels could be tracked more easily. Also, the provision of a more suitable syllabus at each of the different levels ensured that the SEFI Core Curriculum could also continue to be implemented. The importance of these issues is echoed by Griffith (1985) who researched into the engineering curriculum. His findings show that many of the previous studies have resulted in updates to the curriculum, and will need to continue to do so.

Criteria	Old	New
How many units are there in a		
BTEC NATIONAL DIPLOMA	16	18
BTEC NATIONAL CERTIFICATE	10	12
BTEC NATIONAL AWARD	N/A	6
How many overall grades are there in a		
BTEC NATIONAL DIPLOMA	N/A	3
BTEC NATIONAL CERTIFICATE	N/A	2
BTEC NATIONAL AWARD	N/A	1
What are the (maximum) UCAS points for a		
BTEC NATIONAL DIPLOMA	N/A	360
BTEC NATIONAL CERTIFICATE	N/A	240
BTEC NATIONAL AWARD	N/A	120
What is the broad anticipated equivalence of A Levels of		
BTEC NATIONAL DIPLOMA	N/A	3 A Levels
BTEC NATIONAL CERTIFICATE	N/A	2 A Levels
BTEC NATIONAL AWARD	N/A	1 A Level
Is there External Assessment in		
BTEC NATIONAL DIPLOMA	No	Yes
BTEC NATIONAL CERTIFICATE	No	Yes
BTEC NATIONAL AWARD	No	Yes
Are there BTEC Common Skills in:		
BTEC NATIONAL DIPLOMA	Yes	No
BTEC NATIONAL CERTIFICATE	Yes	No
BTEC NATIONAL AWARD	N/A	No
Do students have to pass all units in		
BTEC NATIONAL DIPLOMA	Yes	No
BTEC NATIONAL CERTIFICATE	Yes	No
BTEC NATIONAL AWARD	N/A	Yes
How many units are students required to pass for a		
BTEC NATIONAL DIPLOMA	16	16
BTEC NATIONAL CERTIFICATE	10	10
BTEC NATIONAL AWARD	N/A	6
How many units are students required to complete in a		
BTEC NATIONAL DIPLOMA	16	18
BTEC NATIONAL CERTIFICATE	10	12
BTEC NATIONAL AWARD	N/A	6

Table 3.2: Table of Qualification Differences (Edexcel 2003, Page 2)

It was as a consequence of all of these issues that there were several changes, both to the qualification and to the unit content. These have brought the various qualifications closer into line with each other and also ensured that the SEFI Core Curriculum is covered adequately. The differences between the old and new qualifications are detailed by Edexcel in Table 3.2.

To make the table clearer, looking at each horizontal block, the first block shows the number of units of study for each of the qualifications, the second shows the number of graded outcomes given for the overall qualification, the third shows the maximum available points score for the UCAS system, the fourth shows the equivalent number of A levels for the qualification, the fifth shows whether an external assessment is included in the qualification, the sixth shows whether Common Skills are assessed as an integrated part of the qualification, the seventh shows whether it is necessary to pass all of the units, the eighth shows how many units need to be passed to gain the qualification, and the ninth shows how many units have to be attempted in order to gain the qualification.

These changes bring the qualifications in line with A levels by making them the same both in equivalence of level and in UCAS points. There are now two more units that have to be studied and completed, but the requirement of the number of units to pass is still the same as before. There is also an external assessment included in the new qualification, but Common Skills are no longer assessed as an integrated part of the qualification.

Under the pre-2003 syllabus, there were 14 different topic areas which all had to be covered, and passed, see Table 3.3. For each of these topic areas, there was a set of performance criteria with an associated range, e.g. under topic (or outcome) 3 – *Use tables and charts in the solution of problems* – performance criteria 2 relates to *Relevant reliable information extracted from charts* – and the range is *Graphs, Nomograms, Gantt charts, Pie charts, Histograms and Bar charts*, see Appendix A, Section 1.

Mathematics for Engineering 1992 Syllabus 14166H (OLD)
1 Make use of appropriate (electronic) aids to calculation
2 Obtain reasonable answers to engineering problems
3 Use tables and charts in the solution of problems
4 Perform calculations in various number systems
5 Solve problems using given formulae
6 Solve problems expressed algebraically
7 Use graphical methods to evaluate data
8 Use calculus for engineering problems
9 Use numerical methods for integration
10 Use trigonometric relationships in engineering contexts
11 Evaluate physical properties in given situations
12 Use basic statistical concepts to handle data involving no more than two variables
13 Represent physical quantities as vectors
14 Use complex numbers to model engineering systems

Table 3.3: Table of Pre 2003 Syllabus Topic Areas

This meant that in order to pass this particular topic evidence had to be provided which showed coverage of all 6 of the range, together with any other appropriate performance criteria and ranges also listed under outcome 3. The level of the work produced was an indicator of the grade for that topic area. The full set of 14 grades would then be looked at to decide what overall grade would be awarded for the unit.

Under the 2003 syllabus the content is split up into grading criteria, see Table 3.4. The level is determined by the set criteria. All 16 criteria have to be covered, but it is only necessary to show evidence of success with the 8 P criteria, which are the PASS criteria. If a single P criterion is not achieved, despite gaining M and/or D criteria, the unit cannot be signed off as a Pass. The content is less, but there is no compensation between topic areas by balancing higher and lower grades overall. The P criteria are the pass criteria, the M criteria are the merit criteria and the D criteria are the distinction criteria.

These are all set by the examining body, and are not subjective – it is either achieved, or not achieved.

Mathematics for Technicians 2003 Syllabus 2288U (NEW)		
P1 manipulate and simplify algebraic, logarithmic and exponential functions	**M1** apply algebraic laws and trigonometric functions to the solution of realistic engineering problems	**D1** solve realistic engineering problems which involve the mathematical manipulation and analysis of relatively complex algebraic, exponential and trigonometric functions
P2 use standard formulae to find surface areas and volumes of regular solids	**M2** apply statistical methods to the analysis of statistical, scientific and experimental data and make realistic estimates and predictions from such an analysis	**D2** apply graphical methods to the solution of engineering problems that involve exponential growth and decay, logarithmic and sinusoidal functions
P3 solve triangular and circular measurement problems involving use of the sine, cosine, tangent and radian functions	**M3** produce answers to a problem involving the determination of the standard deviation and variance	**D3** apply the rules for definite integration to engineering problems that involve summation
P4 use graphical methods to produce answers to simple problems involving algebraic, trigonometric and oscillatory functions	**M4** use graphical methods to find the differential coefficient of simple exponential and sinusoidal functions	
P5 manipulate statistical and scientific data, and produce statistical diagrams and graphical solutions from such data	**M5** differentiate algebraic, exponential and trigonometric functions using the basic rules	
P6 produce answers to statistical problems involving the determination of mean, median and mode		
P7 differentiate polynomial and other simple algebraic expressions		
P8 use the rules of integration to find indefinite and definite integrals of basic polynomial functions		

Table 3.4: Table of 2003 Grading Criteria

Comparison of 1992 syllabus to 2003 NQF syllabus	
1, 5,11,13	Not specifically targeted
3, 4, 9, 14	Removed
2, 6, 7, 8, 10, 12	Tiered into grading criteria
6, 10	*Tiered into grading criteria above Pass level*
7	*Tiered into grading criteria, but polar, square and sawtooth waveforms removed*
12	*Tiered into grading criteria at Pass and Merit level*
2	*Tiered into grading criteria at Distinction level only*

Table 3.5: Table of Syllabus Comparisons

The table 3.5 shows what changes have been made from the pre-2003 syllabus to the 2003 syllabus. This table shows that several of the topics were not included in the 2003 scheme, such as complex numbers. (Both full syllabi are included in Appendix A – Sections 1 and 2). The changes to the unit reduced the overall content to be delivered, but also targeted topic areas for grading criteria. This was a radical change to the assessment process.

14166H 1992 Syllabus (OLD)	**2288U 2003 Syllabus (NEW)**
STRUCTURE	
All 14 topic areas have to be fully covered and fully demonstrated	All 16 criteria have to be delivered, but only the 8 Pass criteria have to be fully covered and fully demonstrated
Each topic area has a set of performance criteria with an associated range. Each item within the range has to be demonstrated to gain the performance criteria	Topic areas are split between grading criteria. Some topics are Pass level only, but others are Merit or Distinction, or a mixture of these grades
PER TOPIC AREA	
A Pass is obtained by successfully achieving the full range of a performance criteria	Not Applicable
A Merit is obtained by successfully achieving the full range of a performance criteria at a higher level than Pass	
A Distinction is obtained by successfully achieving the full range of a performance criteria at a higher level than Merit	
OVERALL	
All need to be Pass to get PASS or higher grades	All 8 Pass criteria are needed to get a PASS
At least 2/3 need to be Merit or higher to get MERIT	All 8 Pass and all 5 Merit criteria are needed to get a MERIT
At least 2/3 need to be Distinction to get DISTINCTION	All 8 Pass, all 5 Merit and all 3 Distinction criteria are needed to get a DISTINCTION

Table 3.6: Table of Unit Assessment Differences

This seemed to be an ideal point at which to monitor the effects of this change. Under the previous syllabus, there was a wider range of topics, several of which required in depth coverage. All topic areas had to be covered to their full depth for a student to be able to pass. Consequently, the old mathematics unit was one which the students perceived as being difficult to succeed with, due to the volume of work required. The assessment differences are detailed in Table 3.6. The new syllabus, however, gives a smaller range of basic topics which have to be achieved, with the more in depth knowledge being assessed at a higher level. On an outcome basis this equates to 8 topics in the ‘New’ syllabus against 14 topics with an overall range of 82 applications from the ‘Old’ syllabus.

3.6 Qualifications Comparison

Although the whole course is equivalent to either 2 A levels (certificate) or 3 A levels (diploma), this is not the same as having an A level in mathematics. There is quite a lot of overlap, but also several differences. Certificate students will only study Mathematics for Technicians whilst diploma students will study Further Mathematics for Technicians as well. Mechanical based certificate students will, however, also study Mechanical Principles and Further Mechanical Principles whereas Electrical/electronic based certificate students study Electrical/Electronic Principles and Further Electrical/Electronic Principles. These units all contain mathematics applied to the discipline, and these units are considered much more challenging mathematically than the actual mathematics units. This is partly due to the complexity of the subjects concerned, but also to the level and depth at which the mathematics has to be used. They are considered as Science modules, due to their practical applications. In total, there are 12 units to a certificate (2 A level equivalent) and 18 units to a diploma (3 A level equivalents). This roughly equates to each unit being one sixth of an A level.

A level mathematics consists of Core 1, 2, 3 and 4 together with any 2 of various permitted combinations from Mechanics 1, 2; Statistics 1, 2; and Decision 1, 2. By drawing up a comparison table, based around the A level syllabus, it will be possible to check the exact equivalence of the two qualifications. If Core 1, 2 and Statistics 1 are considered for AS level and Core 3, 4 and Statistics 2 are considered for A2 level, further comparisons can also be made. Tables 3.7, 3.8, 3.8 and 3.10 show the coverage of the Core (1-4) subject areas, whilst Tables 3.11 and 3.12 show the coverage of Statistics 1, 2.

CORE 1	Main Topic	Sub Topics	Mathematics for Technicians	Further Mathematics for Technicians
1	Algebra & Functions	1	Covered	
		2		
		3	Covered	
		4	Covered	
		5	Covered	
		6	Covered	
		7		
		8		Covered
		9		Covered
		10		Covered
2	Coordinate Geometry	1	Covered	
3	Sequences & Series	1		Covered
		2		Covered
4	Differentiation	1	Covered	
		2		Covered
		3	Covered	Covered
5	Integration	1	Covered	
		2	Covered	Covered

Table 3.7: Comparison of Core 1 with Engineering Mathematics Units

CORE 2	Main Topic	Sub Topics	Mathematics for Technicians	Further Mathematics for Technicians
1	Algebra & Functions	1		
2	Coordinate Geometry	1		
3	Sequences & Series	1		Covered
		2		Covered
4	Trigonometry	1	Covered	
		2	Covered	
		3	Covered	
		4		Covered
		5		Covered
5	Exponential & Logarithms	1	Covered	
		2	Covered	
		3	Covered	
6	Differentiation	1		Covered
7	Integration	1	Covered	
		2	Covered	
		3		Covered

Table 3.8: Comparison of Core 2 with Engineering Mathematics Units

CORE 3	Main Topic	Sub Topics	Mathematics for Technicians	Further Mathematics for Technicians
1	Algebra & Functions	1		
		2		
		3		
		4		Covered
2	Trigonometry	1		
		2		
		3		
3	Exponential & Logarithms	1	Covered	
		2	Covered	
4	Differentiation	1	Covered	
		2		Covered
		3		
5	Numerical Methods	1		
		2		Covered

Table 3.9: Comparison of Core 3 with Engineering Mathematics Units

CORE 4	Main Topic	Sub Topics	Mathematics for Technicians	Further Mathematics for Technicians
1	Algebra & Functions	1		
2	Coordinate Geometry	1		
3	Series & Sequences	1		Covered
4	Differentiation	1	Covered	
		2	Covered	
		3	Covered	
5	Integration	1	Covered	
		2		Covered
		3		Covered
		4		Covered
		5		Covered
		6		Covered
6	Vectors	1		Covered
		2		Covered
		3		Covered
		4		Covered
		5		Covered
		6		Covered

Table 3.10: Comparison of Core 4 with Engineering Mathematics Units

Statistics 1	Main Topic	Sub Topics	Mathematics for Technicians	Further Mathematics for Technicians
1	Models in Probability & Statistics	1	Covered	
2	Representation & Summary of Data	1	Covered	
		2	Covered	
		3	Covered	
		4	Covered	
3	Probability	1		Covered
		2		Covered
		3		Covered
4	Correlation & Regression	1		Covered
		2		
		3		
5	Discrete Random Variables	1		Covered
		2		Covered
		3		Covered
6	Normal Distribution	1		Covered

Table 3.11: Comparison of Statistics 1 with Engineering Mathematics Units

Statistics 2	Main Topic	Sub Topics	Mathematics for Technicians	Further Mathematics for Technicians
1	Binomial & Poisson	1		Covered
		2		Covered
		3		Covered
2	Continuous Random Variables	1		Covered
		2		Covered
		3		Covered
		4		Covered
		5		Covered
3	Continuous Distributions	1		
		2		Covered
4	Hypothesis Tests	1		
		2		
		3		
		4		
		5		
		6		

Table 3.12: Comparison of Statistics 2 with Engineering Mathematics Units

None of Mechanics 1or 2 is covered in the mathematics units – this is dealt with in the mechanics units, which covers Mechanics 1, 2, 3, 4, and 5, so covers all of this part of the A level mathematics syllabus. Decision 1 and 2 is not covered anywhere within the certificate or diploma units.

From the tables it can be seen that for individual sub topics that 11% of Core 1, 13% of Core 2, 57% of Core 3, 11% of Core 4, 13% of Statistics 1 and 44% of Statistics 2 are not covered. This is the same as 12% of AS and 35% of A2 individual sub topics not being covered. Overall this means that 24% of the full individual sub topics at A level are not covered. If the main topics are considered, then the picture changes slightly. Once again, it can be seen from the tables that 0% of Core 1, 29% of Core 2, 20% of Core 3, 33% of Core 4, 0% of Statistics 1 and 25% of Statistics 2 are not covered. This is the same as 11% of AS topics and 27% of A2 topics not being covered. Overall this means that only 18% of the main topics are not covered at all. The Further Mathematics for Technicians syllabus is included in Appendix A, Section 3.

The Mathematics unit in year 1 covers two fifths of the AS syllabus and one fifth of the A2 level syllabus. Taking the whole of the mathematics A level, this is approximately one third of the syllabus in year 1 of both the certificate and diploma and approximately two thirds of the syllabus by the end of year 2 for the diploma. The mechanical students would also have covered the whole of the Mechanics 1 and 2 syllabi as well, so they would be much closer to the complete A level. However, as the mathematics units are only supposed to be equivalent to one sixth of an A level, then clearly the amount of mathematics covered is considerably more than the supposed equivalent.

3.7 Outside Demands

There has been a general problem of gaining access to lecturers when needed by individual students and a lack of suitable texts for independent study mirroring the syllabus. Also, local engineering employers have been requesting that suitable reference material be made available via the internet in both “text book” and visual styles for their day release employees. Several of the local employers had requested extra mathematical support for their employees who were studying under the old syllabus, but had problems releasing students to spend time at the college. This meant another solution, other than providing formal lectures, was required.

The demand by employers and students for more mathematics study materials seemed to be the ideal opportunity to work towards the College initiative to make fuller use of online learning through the VLE by use of Blackboard. This approach would allow greater flexibility, but it also has the potential to broaden and enrich the mathematical content at a later date by linking the material more clearly into the other engineering units. An interactive content with direct links to engineering uses would allow the cross mapping of resources across modules to support an integrated content delivery. Pure mathematics changes to an application by its linking and the usefulness becomes apparent. This would contextualise material for individual engineering applications according to specialism – e.g. use within electrical differs from use within mechanical although the original mathematics slides are generic. This would then help the students to apply their mathematical knowledge as a transferable skill, and make them more prepared for life long learning. This trait was identified by Dearing (1997) as a significant benefit of great value to employers.

3.8 Summary

This chapter described the backgrounds of the various students studying engineering mathematics at the College and the changes to recent syllabi which were applicable to their mathematics qualification. It then related this to how the research arose naturally from concerns related to their mathematical education. The rationale behind the use of the VLE to aid the students was mentioned and this leads on to the next chapter, which discusses the college's desire to embrace specific technologies which are compatible within a Managed Learning Environment (MLE).

CHAPTER 4

EVOLUTION OF E-LEARNING WITHIN THE COLLEGE ENVIRONMENT

4.1 Introduction

This chapter details the changes that have occurred within the computing resources and VLE resources during the life time of this research project. It begins with the first use of an accessible virtual learning resource, which was first trialled at the College in the academic years of 2001/02 and 2002/03; and describes the changes that occurred between then and 2009/10, together with the rationale behind the changes. There is also a section on Tegrity Systems, which was the original motivation for this research, but which became unusable and was replaced by the use of the VLEs in their own right. Much of the information in this chapter has been elicited from technical personnel, such as IT Managers and VLE Managers, and as a consequence there are several technical and computing terms used within this chapter.

The vision set out in the ILT Strategy (Turner, 2002) states that *"ILT will transform the business in the next three years, given sufficient investment".* (Page 6)

4.2 Computing Resources

The information in this section was mainly from individual interviews with key personnel, unless otherwise stated.

The ILT Strategy (Turner, 2002) suggested that the ILT resources would be made available to allow 24 hour and 365 day availability of the online resources from any computer connected to the internet. Along with this there was the potential additional purchase of data projectors for all teaching rooms together with internet availability in all class rooms and staff work areas. To update computer availability for students the ratio needed to be increased from 1 to 5 FTE students to 1 to 1 whilst also replacing older stock. The speed of this would be entirely dependent upon how much revenue could be apportioned to this aim. The infrastructure requirements also needed to be considered and for the system to be reliable there had to be sufficient bandwidth to sustain the volume of traffic anticipated as well as the capability of supporting all types of content, including multi-media, videoconferencing and streaming applications.

The dedicated servers cost in the region of £2500 to £3000 each, with an annual institutional licence fee in the region of £7000 ($5000) for the Blackboard software and a further £11000 for the Dell Blackboard server. The change over took about three months to implement, and there was a similar amount of time to make sure it was running correctly before it was able to go live. It took at least two to three days per week over the six month period for five members of staff with salaries ranging from technician levels up to high management levels.

Blackboard was a really good system, but the licensing costs changed from an annual fee to a per student cost. This meant that with up to 30,000 students the College would be liable to a minimum fee of £15,000, which was clearly too expensive. However, moving to Moodle meant that the software was free, as it has been developed as open source freeware. Also, it has a lot more features than Blackboard. The expansions included such things as email, text messaging and graphical interfaces and they were far more flexible in the ways they could be used. Moodle was highly customisable through in-house hacking and there were also open source third-party modules available to add in. There were also global community support for usage guidance and technical debugging for Moodle whereas Blackboard was a more restricted market. The main problem was the migration of existing courses from Blackboard to Moodle. It was a very lengthy process taking one person 3 months full time to migrate the 190 courses.

Moodle runs on standard web browser languages so it was relatively cheap to set up. There were some problems to do with the integration with other established systems, such as the Novell, e-directory. This undermined staff confidence in the system and the logins were not as streamlined as they should have been.

The system used at the College is very viable. Everything is progressing towards internet access and being browser based. In the future it won't even be necessary to have a PC – a hand held or 3G mobile phone will be just as adequate – which means that the use of applications will be different from how it is at the moment. Blackboard was the first system the College used, nothing was piloted before this, but the systems are gradually moving towards the standards of Facebook, MySpace, and Wikipedia, where people can contribute what they like to them.

At the moment the system does not necessarily fit into the wider picture of a city-wide learning platform. Moodle support Zhiblouth authentication, so it would be possible to allow other institutions with Zhiblouth access to specific areas through authentication and login rights.

There are likely to be many issues with regards to Zhiblouth, both with regards to manpower and hardware. There will be a reliance on storing huge amounts of data and with this there are legal implications. Audit systems will need to be in place in order to trail what is being stored, how it is being stored, and for how long.

4.3 Virtual Learning Environment Resources

Once again, the information in this section was mainly from individual interviews with key personnel, unless otherwise stated.

The provision of student accounts on the computer network allowed students the added flexibility of using the VLE resources in addition to their previous use of emails and storing electronic work. No student was able to access the resources without having a student computer account. Initially this caused some problems, but once passwords and logins were sorted out, this was no longer an issue. With Moodle it is possible to create the look and feel as you require more simply than with Blackboard. It was also easier to integrate with the operating systems and to make more secure. There is a broad selection of authentication methods and it will soon be possible to use Moodle networking to enable a single sign-on to other web systems. This will be particularly useful in light of the large scale regional and national adoption of Moodle in colleges and universities where inter-institutional support occurs.

The VLE Manager spent several hours per week working on the system to improve it and research new ways of using it more effectively. There was also the training put on for staff. This was a regular on-going cost and was covered within the VLE Manager’s job description. Previously this was covered by the Lead IT Champion who was specifically employed to train staff on how to use the VLE and produce resources for it. A hidden cost is the time spent by staff in preparing the resources for the VLE. On average, it took 6 hours to produce the basic materials for an individual lesson of about 2 hours in length.

Staff training on how to use the resource and how to prepare materials was run regularly at the start. There were frequent one to one sessions as well as half day training sessions. This was an essential element in the beginning because it was so different from the way the majority of staff had worked. This included the need for ICT support as many staff did not have the necessary ICT skills when this began, and were reluctant to use the system because of this. It was more to do with moving beyond Word documents into using multimedia and creating HTML resources rather than Blackboard itself. The key to this resource was that the student did not have to be on site to access it. The lecturers still had to control the information, updating it, responding to students, giving feedback, etc.

The pace of development has meant that the College Moodle system was behind other current versions. Academic data could not be jeopardised, so any upgrading had to be carried out during the summer when most staff and students used the system less frequently. With the new innovations more diverse types of resource and a greater variety of activities could be included. There were a whole variety of these Moodle plug-ins available around the world, as there was a standardised way of developing these tools so that they could just plug in straight away and provide extra working features.

Lots of the features were about making it easier to do things. There could be an initial cost if we go with a texting service, but that could be done as part of an educational package. We have been using Elk as an e-portfolio system, but when it becomes available through Moodle we would probably switch to that instead. The College was very reliant on staff producing the resources for Moodle. It would have been useful to have been able to buy in third party training materials as well.

Upgrading was done weekly with the use of a network technician. There was due to be a big upgrade from version 1.5.3 to version 1.8 during the summer (2007) break. The system had more features and it was easier to use. The Open University were enhancing the quiz module, so that would be another feature we would upgrade in the future. There was also going to be a Hub Moodle – which meant that all institutions using Moodle would be able to link seamlessly and share materials, if there were agreements in place between the institutions. This would allow clusters of Moodles talking to each other which opened up things for cross-college collaborations, sharing of workloads costs and new features, and even content.

There was more focus now on the quality of the materials themselves, rather than the fact that they existed. This applied not only to the actual materials that staff created but also to the legal aspects as well. This would include publishing licenses – is it covered for the internet? Were the images, web links, third party material conforming to licence agreements?

Moodle should be viable for the foreseeable future – they have pledged to remain open source forever. It was sponsored by Google and many top universities and colleges had students developing it to sustain its market share and to enrich its features. It was one of the fastest growing platforms, but the hardware development was keeping up to speed with the software. Microsoft has sponsored some development on database compatibility and that was a seal of approval from the biggest company in the world. It was very easy to re-brand Moodle so that it took on the corporate image of the institution it was being used by.

One of the developments under consideration is to link in calendars – to mobile devices or other calendars – through something standard that can pass the data through different platforms. It would also be possible to put College timetables up onto Moodle so that students could have easier access to them and they could be texted about any changes. By feeding an individual's Moodle calendar through their Google calendar it would be possible to send an SMS message to remind them of certain events, thereby splicing with other third party technologies like Google, Facebook, etc where students already have a profile. There is also the Microsoft initiative with open identities under the web 2.0 philosophy of user led/student led initiatives. They can direct their own learning and organise themselves. There is a huge opportunity for future developments in this area.

4.4 VLE Systems

This section explains how the VLE platform was expected to be used. The Faculty of Technology wanted to push the boundaries of the VLE to make it more useful for their day release and apprentice students. The idea was that recordings of lectures could be posted using the Blackboard platform by converting PowerPoint delivery and lectures into web content for on-demand and live delivery. It seemed to be a sensible addition to the college-wide Blackboard platform to improve the resources available to students.

This relates to the ILT Strategy 2002/5 for the College (2002). Within the Technology department

> *"it is anticipated that the use of the VLE will increase and the use of web-based delivery will become much more common, using on-line video streaming technology".*
>
> (Page 16)

It is possible to include interactive slides, web tutorials and annotated objects. The cost is hidden in that it takes lecturer time and does not impact directly upon the finances of the college. In view of the financial considerations at the time, this was seen as the best way to proceed, with the production of such materials to become part of the lecturers' job description, and with specific standards for the course sites to be laid down at a future date. For example, Figure 4.1 shows an interactive demonstration for sine and cosine curves. There are three separate Excel screens that can be accessed, and each has its own interactive buttons. This is fully accessible through the Blackboard resources.

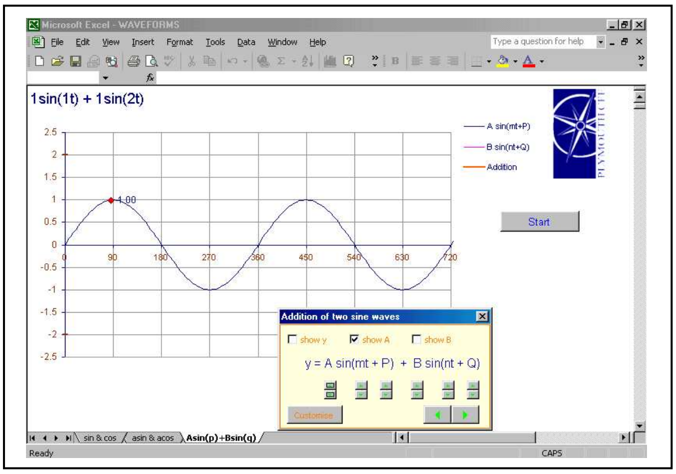

Figure 4.1: Object Activation

There is also the ability to integrate web based tutorials within this system. Figure 4.2 illustrates an example of a web software tutorial. This budgeting tutorial has also been added into the Blackboard system, but has come from internet sources. This means that a seamless presentation can still be built capturing many items in an on-going way, with just a bit more work by lecturing staff.

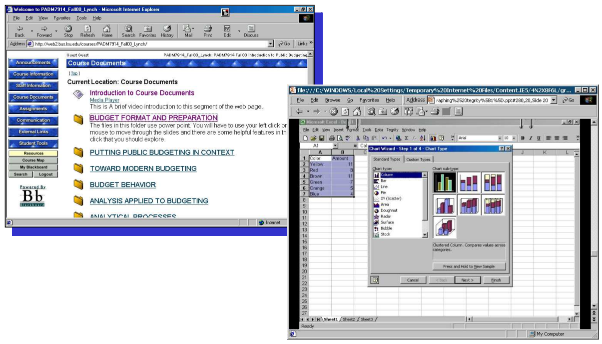

Figure 4.2: Web Software Tutorial

Similarly, images of any 3D object can also be easily imported and then annotated. Figure 4.3 is the same object before and after annotation.

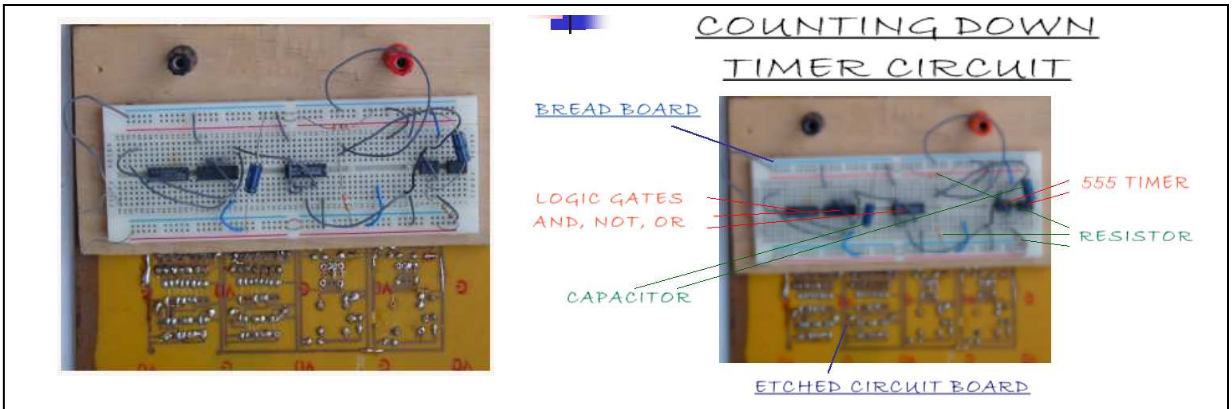

Figure 4.3: 3D Object and Annotated 3D Object

Live feed, could also be added through use of a Webcam. However, due to the age of many of the students, this addition was not used. Several of the students were not able to get (or prepared to give) written permission to be photographed or videoed.

4.5 Application

By 2002, ILT Champions had been appointed in all academic curriculum teams, and were led by the ILT Champion Co-ordinator. They were responsible for ensuring that all curriculum teams were provided with adequate support to develop their VLE materials. The role and progress of this team was annually reviewed so that good practice was disseminated whilst any other issues were also resolved. The benefits of the VLE system were allowing staff to store course material in a central place. This made it easier to access, update and control. There was a lot of flexibility in that the staff could hide future lessons and only allow students to see the materials on a week by week basis. It was a new tool that could add another dimension to what was happening in the classroom. It was another way to access a lot of resources, it allowed students to be more independent, to differentiate the learning better and it enabled remote learning.

The initial take up was poor. There were the enthusiasts who were keen to get involved, and once the staff training of these enthusiasts began the take up began to grow. The student take up was also poor at the beginning – often reflecting the attitude of their lecturers. There were only a small percentage of students using it on a regular basis. The growth in the A level area was extensive, but there was access to a wide range of electronic materials through examining bodies and organisations targeting their material towards schools. The IT areas were pushing the boundaries and wanting more features that they knew could be used, so their area was prolific. In terms of traffic, in 2006/07, there were approximately 550 staff who had used Moodle, with about 2500 students, out of a possible 6500-7000 students, who had used Moodle. The peak days were Monday to Thursday, with about 300 to 500 logins per day.

Every single course that the College ran had a space available on Moodle. There were approximately 250 courses that were being used on a regular basis. There was a lot more activity than there was on Blackboard. There was a College target to have all long significant courses on Moodle by the end of the 2006/07 academic year. Long significant courses are any course with over seven enrolments which run for more than 16 weeks. This was a total of about 180, and of this there were 100 that had established areas, which was below target. As the College ran about 600 courses in total, there were about one third that were actually being used actively throughout the year. The vast majority of access was during College hours, both by students and staff.

The system itself was easy to use – it had been designed to be user friendly. The user can log in, structure the area that they have access to and control how it is set up – either by sets of folders or by nesting the materials. However, although for those with ICT skills it was easy to use, for those who were not particularly computer competent it was just an extra thing on top of everything else. Staff were starting to see the benefits of the system, but frequently mentioned the lack of time to create and develop resources. However, the effects of having a centralised resource area were very useful for the students. It allowed for flexibility with revision, recapping and absenteeism as well as allowing students to catch up and print out their own materials. Student usage was very enthusiastic and with the internet communication and technologies of the web world the students were living in they take to it very easily. Many had used similar systems at their previous schools. There was usually disappointment that some of the features have been removed.

4.5.1 Syllabus Delivery

The lecture notes for Mathematics for Technicians had been used as the basis of a set of PowerPoint slides. The staff options shown in Figure 4.4 illustrate the Control Panel settings that were available.

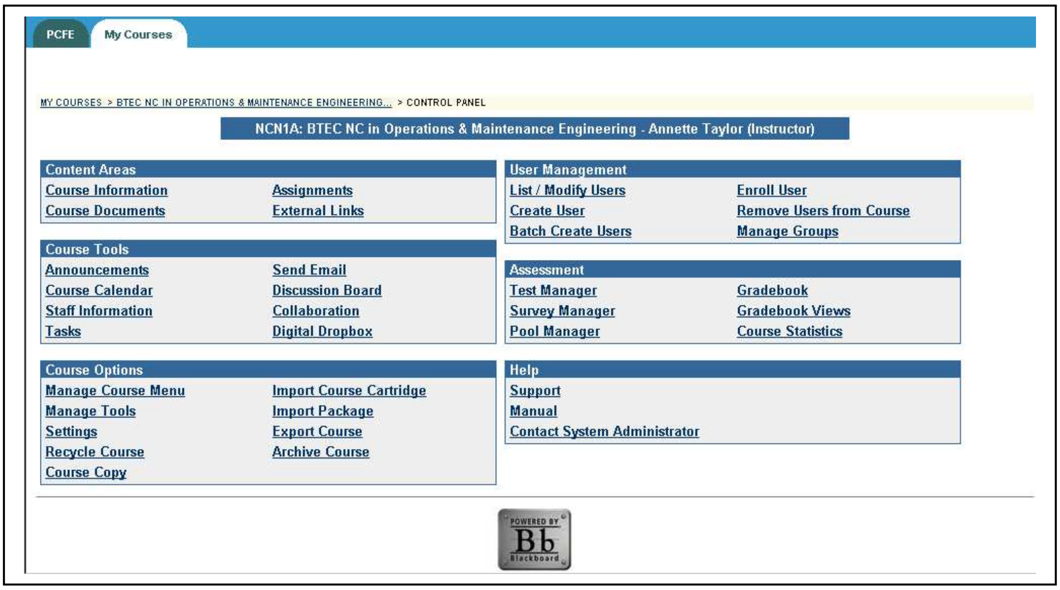

Figure 4.4: Staff Options in Blackboard Format

The syllabus was split up into topics according to the assessment criteria, and each topic contained lesson notes for each of the individual areas that made up the topic. The lesson notes corresponded to the weekly delivery of the syllabus over the year. The menus are shown in Figure 4.5. The lesson was delivered in the normal style, but using the PowerPoint slides projected onto the whiteboard, rather than writing the information with dry markers. The slide projections could be annotated when necessary and captured into the presentation.

The lecture was recorded so that the talk through, explanations and any discussions were also captured into the presentation. The individual lessons were then posted onto Blackboard so that any student with access to these materials could access the lecture and notes at any time via the internet link.

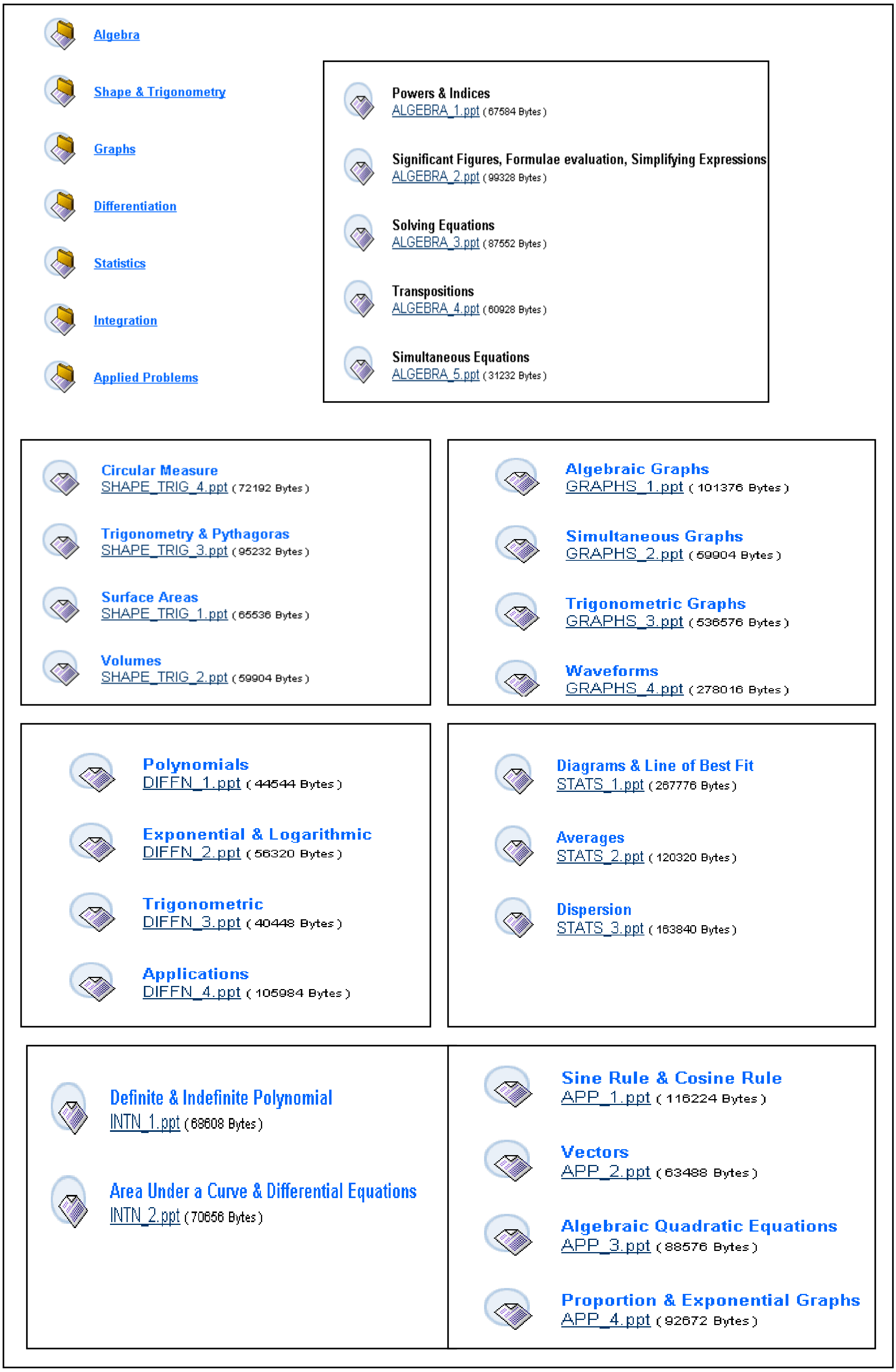

Figure 4.5: Topics and Lessons

4.5.2 Accessibility

The Blackboard platform could be accessed through the College intranet site, both internally and externally. Once the student has accessed the platform, they were automatically directed to the site set up for their class, which was done by class codes. This was all controlled at the login stage, via the students' unique reference. Once the student had accessed their class area they had the choice of what to view.

4.5.3 Navigation

After clicking on the Course Documents icon a new screen would appear. The mathematics unit was clearly labelled and they just had to click on the folder icon to access the unit. Having accessed the unit, there was a choice of assessment areas. If they decided to look at, say, Algebra, then this is split up into the individual lesson topics. They would click on Algebra and then the chosen lesson; let's say equations. The equations lesson dealt with algebraic, logarithmic and exponential equations. The student could choose to look at all three areas, or just a part of the topic.

For example, if exponential equations were chosen, the slides alone gave step by step processes on solving questions and methods, as shown in Figure 4.6. If the audio was included, then the slides were talked through step by step, but also further background information was given about how the topic fitted into the engineering and mathematical content. This format was followed for all of the assessment areas.

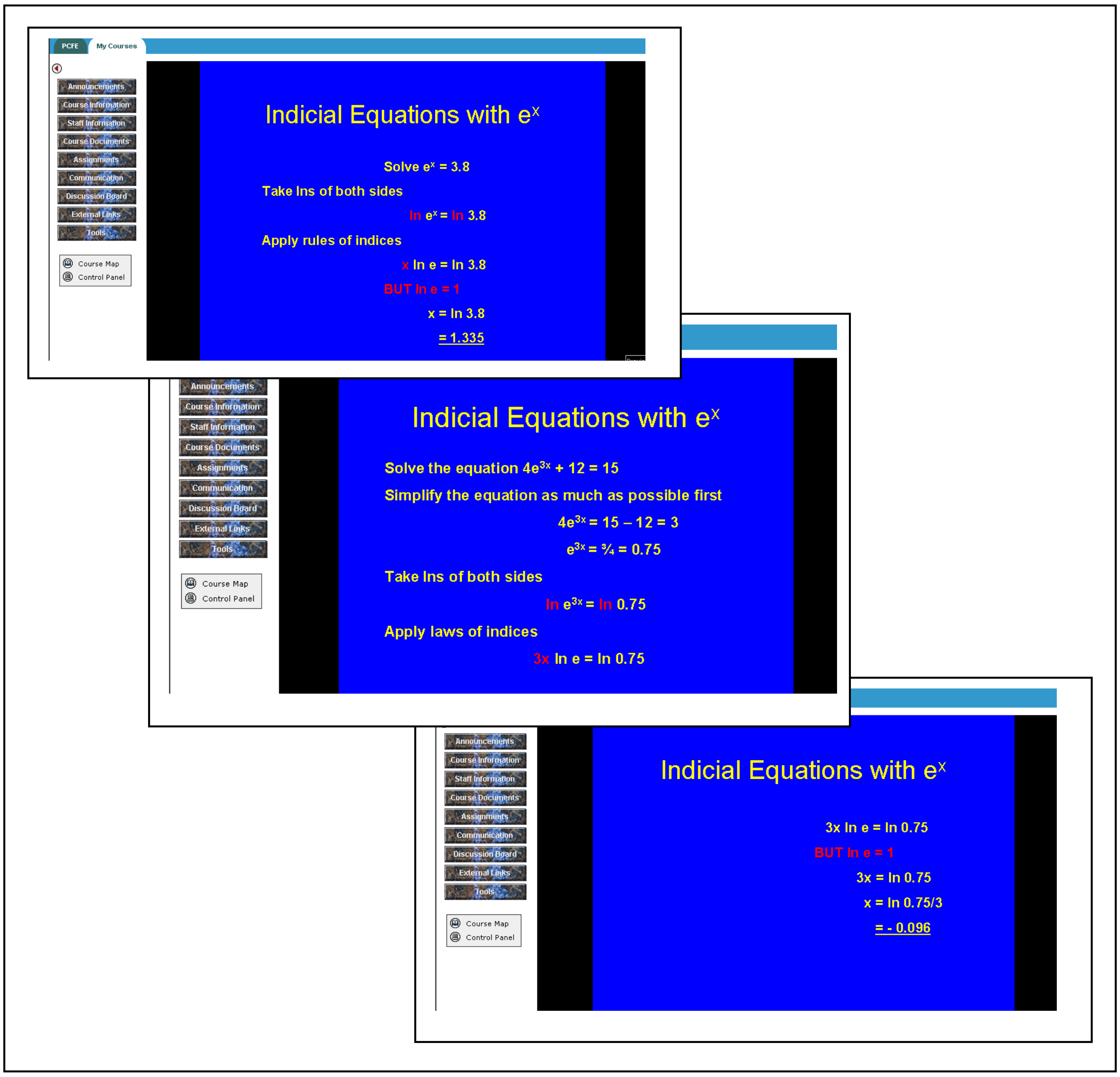

Figure 4.6: Exponential Equations Slides

For example, looking at the topic area of graphs, waveforms were one of the lesson areas. Once again the slides gave step by step processes on solving questions and methods, as shown in Figure 4.7.

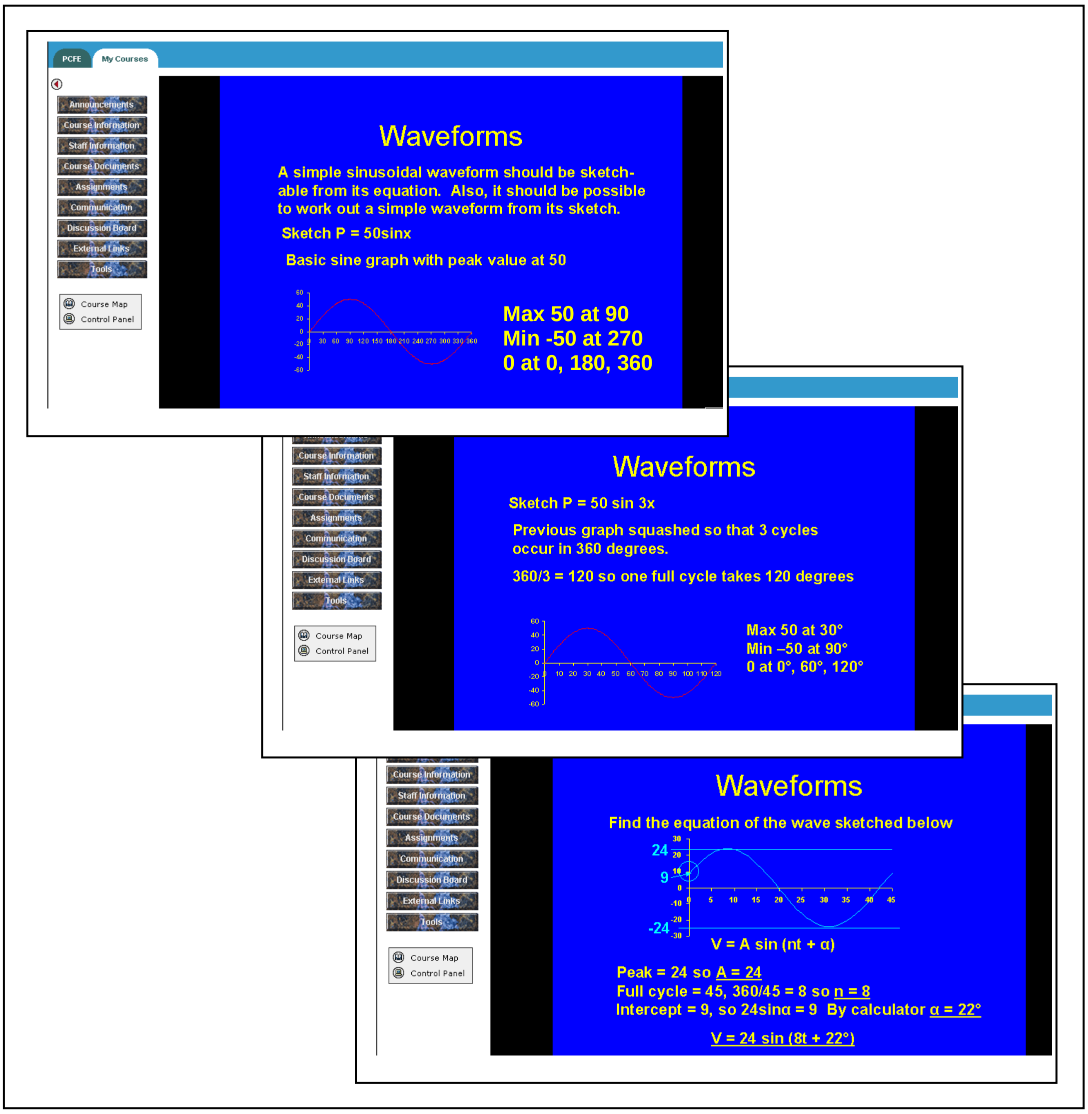

Figure 4.7: Waveforms Slides

4.5.4 Availability

The Blackboard material was available to all engineering students in the Technology faculty in year one. In the first instance, the material availability was advertised to the groups, with a brief demonstration of how to access it. Thereafter, it was referred to as a useful revision source and as a “catch-up” tool for absentees. Once assignment results were known, individuals were targeted to look at specific sections to improve weak areas.

4.5.5 Administration

The system had the tracking feature enabled which allowed individual usage to be monitored, as shown in Figure 4.8. Also, the use of the system was monitored so that it could be improved to suit the students' needs better and also to see whether it had any effect on achievement and attitudes.

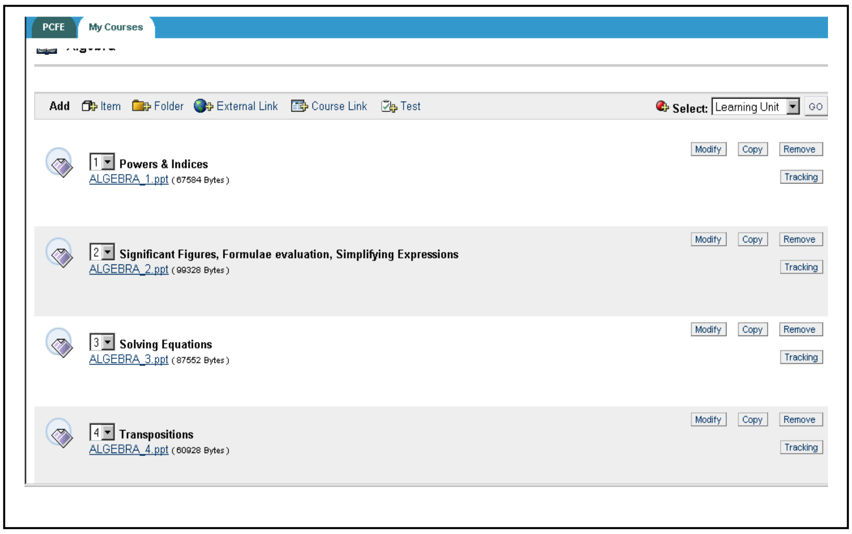

Figure 4.8: Blackboard Tracking Systems Enabled

The tracking facility recorded individual student usage by both time and date. This was recorded against each individual presentation which was posted onto Blackboard. From this it was possible to track what an individual had studied, and for how long. It was also useful to compare which particular topics had been accessed the most. It was also possible to compare the usage of different groups, both the times and the topics. This is discussed in more detail in Chapter 7, where the logging data results are analysed.

4.6 Summary

This chapter explained the implementation of the ILT Strategy (2002) from the original concept through to the actual implementation and upgrading of the systems. The changes of management and direction were also reflected in this chapter, showing how the original concepts had to change and why. This also included both the system set up of the VLE and its application within the College. The rationale behind its use was outlined, and its accessibility was discussed, together with the changes that had to be implemented due to financial and re-structuring issues. Sample slides from the presentation were included to give an idea of both basic and interactive delivery.

CHAPTER 5

METHODOLOGY – OPTIONS AND DECISIONS

5.1 Introduction

This chapter outlines the possible research methods which could be used in this project and discusses the viability of each method with regard to the proposed study. The main focus of the study was to investigate the learning experiences of the students with particular emphasis on the use of a VLE together with a consideration of their achievements within the mathematics module on the national engineering certificate and diploma courses. The most suitable methods are then considered in more detail in order to identify their advantages, and any disadvantages which have to be overcome or minimised. From this the processes used in the actual research study were developed in order to provide answers to the research questions.

5.2 Investigating the Learning Experience

In order to investigate the learning experience, it was necessary to look at the various methods of research available, and to choose the most appropriate for the situation.

Cohen, Manion and Morrison (2000) outline six different approaches to research. Looking at each of the six approaches, the following conclusions could be drawn:-

1. A survey would provide extensive data, but as personal experiences are needed, the data could not be context free, so this was not a suitable method.

2. The conditions would not be controlled, so an experiment would not be suitable.
3. Ethnography looks at events from the participants' viewpoint, so this was a possible method as the research will be based around personal experiences and viewpoints.
4. Context specific interventions used in a cycle of action research would also be a possible method as the research is based around the intervention of a Virtual Learning Environment resource.
5. Case studies would be looking at local situations and individuals, so this is also a possible method, as the research is based around a specific institution and specific courses.
6. Testing and assessment is also a possible method as this occurs regularly within the area to be researched.

This means, that of the six styles described above, the possible choices are between ethnography, action research, case study or testing and assessment. From these four methods, it will be necessary to choose one main research method. To do this, each of the four methods will be considered in more detail, so they will each be considered individually, one by one.

5.2.1 Ethnography

Ethnography involves reporting events from a participative view point. Consequently the description, understanding and explanation of the events would take on a subjective view, for this type of research. The data would need to be gathered over a long period of time and should have a wide coverage. Although the views of the participants would be considered, this was only part of the study, so ethnography was not suitable in this instance.

5.2.2 Action Research

In view of the nature of the research situation – the addition of VLE resources to the formal lectures and classes – the action research method was initially thought to be an appropriate style. This was because the addition could be interpreted as an intervention, which has had to be planned and implemented and would then need to be reviewed. This was also specific to a local problem, so was context specific.

Cohen, Manion and Morrison, (2000), quote Cohen and Manion's (1994) definition of action research as:

> "*a small-scale intervention in the functioning of the real world and a close examination of the effects of such an intervention"*.
> Cohen, Manion and Morrison, (2000), (Pages 226-227).

However, to be true action research, more was needed than this. It was also necessary to have an ongoing cycle of implementation and review which would have impact across the whole curriculum in terms of policies and strategies. This was unlikely to be the case, so action research could not be used.

5.2.3 Case Study

As the study involved a single educational institution and was unique to that institution, using case studies as the main tool seemed to be more appropriate. Case study methods focus upon individuals and local situations. Their purpose, according to Cohen, Manion and Morrison (2000) where they refer to an earlier definition from Morrison (1993), is to collect accounts of the reality of a situation and to contribute to action and intervention. There are, however, several advantages and several disadvantages in using the case study method, all of which needed to be considered. The advantages, based on Cohen, Manion and Morrison (2000), which consist of eight supportive reasons, are considered first.

1. The research can be completed by only one researcher, which was an important consideration in this case. It was unlikely that any extra researchers would be involved in a significant way, so being able to complete the undertaking with only one person conducting the research was very important from a practical perspective.
2. The research does not attempt to control events, or intervene; it just focuses on what is happening and takes snapshots at various time intervals in order to build up a more complete picture. This would be appropriate as the VLE resources are available for use, but are not the delivery mode being utilised. A case study would build up a picture of how, when, where and why the resources are used by the students.
3. A variety of methods can be used to gather the data for the case study. There is no single exclusive method; anything that is appropriate may be used. This flexibility would allow a variety of methods to be used together to gather data at several intervals, and help in ensuring its validity and reliability. For example, it would be possible to use questionnaires, interviews, diaries, course data results and prior qualifications.
4. The case study describes how things happen and aims to explain why. This is the kind of information that would be important in helping to improve the learning experience of the students.

5. Similar situations would be able to take information from the case study and apply its findings to the other situations, for example another FE college.
6. Unexpected findings, as either events or occurrences, can be checked further by altering the way the case study is investigated, or by increasing the depth or variety of questions being asked.
7. Individuality or uniqueness does not get hidden by the expected answers. Rather, it enriches the findings by giving an extra dimension that would otherwise be obscured.
8. The reporting style for a case study has to be more descriptive due to the uniqueness of the situation being investigated. This should make it easier to follow what has happened and understand the findings.

This is summed up by Bell (1999) who states:

> *"The great strength of the case-study method is that it allows the researcher to concentrate on a specific instance or situation and to identify, or attempt to identify, the various interactive processes at work"*
>
> Bell (1999), (Pages 10-11).

The four main disadvantages, based on Cohen, Manion and Morrison (2000), are:

1. The study may not be typical or representative so that it is difficult to generalise from the findings. If it is not open to generalisation then it may not be able to be replicated at a later date by others who wish to research the situation further.
2. There is difficulty with cross checking, which means problems with validity and repetition. This can be in the selection of what is

investigated, the bias in what is included from the findings, personal interpretations of findings and the subjectiveness of the participants.

3. The observer may be biased in what they are hoping to find and thereby ignore some of the findings as being insignificant.
4. The sampling of the participants to ensure a suitable cross section may not be representative. This may be limited by the people to whom the researcher has access, rather than a representative section.

All of these problems could be minimised for this study. The situation under investigation may be unique in that it uses a VLE accessed through Blackboard, but the findings would not just be applicable to the College. Some of the findings would be unique to the College, but others could be generalised.

To overcome the problems in cross checking it would be important to check the same things over a period of time, and in different ways. This form of triangulation should improve the validity of the findings and the research. The sampling could be the most difficult to implement satisfactorily. To achieve this without bias would be dependent upon the access to students, but as long as there is a variety of attendance modes and disciplines this should also be covered, and can be discussed in final conclusions.

Observer bias should not be an issue as long as the research is approached with an open mind, and there are no pre-conceived notions as to the results that will be obtained. To achieve this, a variety of methods will need to be employed whose outcomes are unlikely to be affected by the observer. Any direct interventions will need to be noted accurately and accounted for in the final analysis. An honest and professional approach is the only practical way forward, with care being taken to avoid both the Hawthorne and halo effects. The Hawthorne effect is the psychological reaction that occurs from taking part in the research, and is often described as “reactivity”; whilst the halo effect is the influencing of judgements based on the researcher’s prior knowledge of the situation or people involved. Cohen, Manion and Morrisson (2000) describe these effects:

> “*The Hawthorne effect is where the presence of the researcher alters the situation as participants may wish to avoid, impress, direct, deny or influence the researcher”.*
>
> *(*Page 156)

> “*The halo effect is where existing or given information about the situation or participants might be used to be selective in subsequent data collection, or may bring about a particular reading of a subsequent situation”.*
>
> *(*Page 156)

The Hawthorne effect would only apply for a short time so would not have lasting results if the research took place over a substantial period of time, and also it would not be helpful to the students to try to influence the research outcomes as they will always have the choice of whether to use the resources available or not. The halo effect can be avoided as all grades and marks have to be approved and checked by the external examining bodies, which provides both an external viewpoint as well as triangulation.

It is intended that the whole cohort will form the population, therefore no sampling will be used initially for the main information, but subsets of this population may be needed for further follow up information, possibly for interviewing. A representative sample would be taken from across the groups to form focus groups using both those who had and hadn't use the VLE and then from this individuals would be picked to follow up further.

Having considered all the issues associated with this methodology and despite its problems the most appropriate tool to use for this research was thus deemed to be a Case Study approach as described in McNeil and Chapman (2005).

5.2.4 Testing and Assessment

Educational establishments require assessment and testing of achievement and performance as part of their remit, so it also seemed sensible to include some testing and assessment. But, this was only one part of the research study, so testing fitted more appropriately as a tool within the case study rather than as the main style of research. Consequently, it is discussed in more detail in the following sections.

5.3 Appropriate Main Tools Available

The appropriate main tools available within case study methods are questionnaires, interviews, accounts, observations, tests, log books, personal constructs and multi-dimensional measurement. All of these are looked at in more detail later in the chapter. A selection of these methods is needed to make triangulation occur. The results are then open to cross checking for validity and reliability.

Wellington (2000) defines triangulation, validity and reliability in the glossary of terms used in educational research:

> ***"Triangulation*** *is the business of giving strength or support to findings/conclusions by drawing on evidence from other sources".*
>
> ***"Validity*** *can be seen as a measure of the confidence in, credibility of or plausibility of a piece of research".*
>
> ***"Reliability*** *[of research] is the extent to which it can be repeated or replicated by another researcher and/or at a different time".*
>
> (Pages 200-201).

This means that the research methods chosen must allow for the use of different data collection methods at different times to allow triangulation and reliability. Validity is more difficult, but by careful choice of both method and the trialling of a pilot study this too should be achievable.

5.3.1 Questionnaires

Questionnaires collect information in a structured, written format. Oppenheim (1992) gives a detailed account of questionnaire usage and design. His views are reinforced by several other authors, amongst them, Fontana and Frey (1998), Bell (1999), Wellington (2000), Keats (2000), Cohen, Manion and Morrison, (2000) and McNeil and Chapman (2005). Questionnaires are usually given to selected people, but not all of these people may be prepared to complete them. They take time to develop and refine, and can be limited in scope by the fixed nature of the questions. As a number of teaching groups are being looked at in this research, questionnaires would allow sufficient data from each person to be collected quite speedily. If the questionnaires were group administered then this would provide a great deal of information in one session and could also give a good return rate. The onus here is on the researcher to ensure that the questionnaire delivers what is required from a research point of view without being tedious, difficult to complete, or hard to understand.

Consequently it was essential to pilot and evaluate the questionnaire before it was used for the research project. Despite these disadvantages, a questionnaire would be an ideal way of collecting a large sample of data, which could be repeated at intervals over the study. This would enable individual teaching groups to be compared as well as considering subject emphasis and other issues without inconveniencing the participants greatly in terms of their individual time. This method seemed to be appropriate for all of the groups under consideration.

5.3.2 Interviews

Oppenheim (1992), Fontana and Frey (1998), and Keats (2000) have all explored the issue of interviewing in depth. Interviews collect information through verbal interaction. Due to the interaction between the interviewer and the interviewee it is possible to a have greater depth in the response to questions than would normally be associated with a questionnaire. It is also possible for the interviewer to focus on something particular or unexpected that is mentioned by the interviewee and to pursue it further. Interviews can also elicit views and perspectives which are not necessarily observable. This is not feasible in the fixed question format of the questionnaire. This viewpoint is also supported by Bell (1999), Wellington (2000) and Cohen, Manion and Morrison (2000).

Interviews can be carried out in formal or informal settings, and there is scope for them to be structured, semi-structured or unstructured. Structured interviewing is used to minimise errors and uses a preset series of questions in which the interviewer remains neutral. Unstructured interviewing is open ended and informal, and frequently used with observation studies. Semi-structured is a mixture of the two styles. There are preset questions, but the interview is open ended. These techniques can be used in conjunction with other data collection techniques to amplify or triangulate, (Fontana and Frey 1998).

Group interviews are good for gathering opinions when individuals are hesitant to contribute on their own. The group can be used to make comments rather than an individual. This helps to bring out general overlying themes which can be investigated further. The group can also help to produce more information as a response from one member may act as a prompt for individuals. The interviewer must control the dynamics so that no one person dominates, everyone participates and everyone provides responses to all the questions, which can be more difficult. This can be a less threatening environment than a 1 to 1 interview, and the participants may be more likely to contribute openly.

Interviewing would be an ideal way to follow up questionnaire results in that representative groups could be interviewed as well as individuals, which would help with triangulation and also prevent too much inconveniencing of the participants. This method also seemed to be appropriate for all the groups under consideration.

5.3.3 Accounts

An account is a record of what has happened. It is frequently a written record, although it could be verbalised. Accounts have to be viewed in the context of social episodes. They may be personal records of everyday events and are used to explain past, present and future actions, (Cohen, Manion and Morrison 2000). This would involve the participants in keeping records which would then need discussing. Accounts can also be used as a basis for interviews to find out more information, or be part of an interview. For many of the participants keeping an account would be considered too much work so would not really be a suitable means by which to collect information, in this instance.

5.3.4 Observations

Observations describe the situation in which the researcher does not interact with the subjects (or situation) and records what is seen or heard in a non-subjective way, (Wragg 1994, Bell 1999, Cohen, Manion and Morrison 2000). There are two types of observations, quantitative and qualitative. Quantitative observation is looking for predetermined responses by using scientific methods of control and standardisation, whereas qualitative observation is looking for individual responses in a more natural way, (Adler and Adler 1998). In the context of this research, this is not a valid technique for observing students in the classroom as the researcher is involved with the subjects, and observation without interaction would be very difficult to achieve. Also, it would be very difficult to record the observation accurately at the time it took place, and a later write up could be subjective. However, electronic observations of VLE use fit the method of observation very well. By enabling data analysis; the computer will log dates, times and topics accessed for each individual; without them being aware.

5.3.5 Tests

Tests provide an opportunity to gather numerical data, and there is a variety of tests and testing methods - depending upon what is being measured - which can be for used with individuals or groups, (Cohen, Manion and Morrison 2000). In order to gain the qualification they are entered for, the engineering students will automatically be tested as part of their course. The results of these tests could also be considered as part of the research data.

5.3.6 Log Books

Log books, or diaries, provide an alternative to observations. The participants keep a record of what they have been doing over a period of time, (Oppenheim 1992, Bell 1999, Wellington 2000). This could be an ideal method for the students to record their actual usage of the VLE in terms of access points, time and topic areas. However, there are several problems with this. As it is requested by the researcher, this could lead to a bias or "research effect" when written up, such as the students using the system more frequently so they can write it up in the diary. Also, students are unlikely to keep an accurate record over any length of time. However conscientious they are at the start of the project, this inevitably dwindles prior to the end of the project. This then questions the validity of the individual record. The process would be time consuming for the students who were prepared to complete it, and would create an unfair work load for them. There is also the ethical question as to the ownership of the diary in the long term. A more appropriate alternative to this would be needed which records this information accurately, such as an internal computer tracking system, which acts as an electronic observation.

5.3.7 Personal Constructs

Personal constructs are statements of personal opinions. They are not necessarily factual, but represent a person's inner feelings and beliefs based on evidence presented to them. According to Kelly (1969) personal constructs are found by the individual sorting of elements into groups of three in which two are similar in some way, but different from the third. The methodology behind this is explored in detail by Jankowicz (2004). The way the elements are different or alike forms the constructs. Important or significant items or people are initially identified to form the elements under consideration. These are then looked at in groups of three to form the constructs, so that opposed values can be assigned, for instance sympathetic v unsympathetic. This is then reproduced on a grid so that the columns identify the constructs per individual element and the rows identify the constructs in terms of the elements. This is the basis for forming repertory grids. This system of analysis provides a good range of data, but is very time consuming as it requires individual participation in interviews to develop the constructs and look at the groupings. This would require too much time from the proposed participants in this study and so would not be a viable technique in this instance.

5.3.8 Multi Dimensional Measurement

The repertory grid concept can be further developed into multi-dimensional measurement. Cohen, Manion and Morrison, (2000), relate this to Kerlinger (1970) who describes multi-dimensional measurement as a method of grouping together similarities. It takes multi-dimensional concepts and scales them so that the underlying variables can be examined. This is done by taking the similar constructs and producing a multi-dimensional concept for each similar pair. Once these have been formed for all pairs, the order of agreement/disagreement is considered, starting from the extremes. All concepts are placed in the scaled grid using this scaling from the extremes until the grid is full. This process takes the basic repertory grid and expands both its detail and data collection into a more informative, but more complex measurement. The methodology is explained in detail in Jankowicz (2004).

This suffers the same time problems as the more basic repertory grid, and so is not a viable technique for this study.

5.4 Answering the Research Questions

The main question to be answered is whether the use of a VLE enhances student learning of mathematics, and if so, how. This breaks down into several smaller questions and these are looked at in more detail later. In order to answer this question fully it will be necessary to split the study into three main areas that require investigation, although the latter two areas do not specifically relate to the VLE. These areas are

1. Resources available through a VLE,
2. Layering Effect
3. Engineering First, Mathematics Second.

This is outlined in the aims of the research in the Introduction (See Ch. 1).

Due to the nature of the research being specific to engineering classes within Technology and Computing at the College, the case study approach seemed most suitable. It does, however, have several weaknesses, as outlined earlier. Nisbett and Watt's list (1984) is summarised in Cohen, Manion and Morrison (2000). The results may be context specific and less able to be generalised whilst cross-checking will not be easy, and there is also the possibility of observer bias. This is outweighed by the strengths that the results should be easy to understand as the study is based entirely on real events and can be undertaken by a single researcher who will be able to build in unanticipated events.

The learning environment first needs to address how the resources are used; i.e. where, when, by whom, what, how frequently, the duration and how this meets the College ILT Strategy 2002/5. Secondly it needs to address the viability of the VLE with regard to the financial costs of setting up the systems, the ease with which the systems can be used, time required in preparation and how this meets the College ILT Strategy 2002/5. The learner's experience needs to look from different perspectives; i.e. the usefulness of the resource, and if so, why, whether the resource meets individual expectations, what effect the resource has on attitudes to mathematics and ICT, how this meets the College Learners' Policy 2004 and how this meets the College ILT Strategy 2002/5. The resource needs to be useful in order for it to be used regularly. Once the curiosity factor has been addressed, it will not be accessed if it does not provide help and support. It is also important that it delivers in a way that suits the students, and is developed in a way that matches their needs. It needs to make learning more accessible as well as more enjoyable. This is needed to help address pre-conceived attitudes towards mathematics. Also, ICT skills need to be developed and honed so that this is not another barrier to learning. College policies are targeted at improving success and achievement so the overall impact on LSC and government targets of retention and achievement are also very important. By implementing the resources on the VLE the spin off that the College is expecting is a marked increase in these figures.

Although the students are given a copy of the learner policy, they are not necessarily aware of its contents. It is unlikely that they will have read these policies unless they have been specifically directed to them during class time. As far as the ILT strategy is concerned, it is posted on the College intranet, but awareness would depend upon accessing the information, which would be unlikely in the majority of cases. However, progress with the aims and objectives outlined in the strategy are an aspect of concern to the College management and the use of VLE resources is part of that strategy.

As these numerous issues of resource usage, viability of the VLE, learner's experience and strategic aims need to be addressed by the research and access to individuals, especially the part time students, would be limited, the use of written questionnaires before, during and at the end of the academic year seemed to be the most effective method of gaining information. These can be followed up by selective interviewing of small groups to gain feedback on their experiences and to explore issues arising from their questionnaires. This would minimise the time required by individuals to produce the necessary data, but by collecting the evidence at different stages over the year any changes of attitude or actions could be more easily tracked. The selective interviewing would be more time consuming, but as a one-off situation would be more acceptable to the participants. By combining questionnaires and interviewing it is possible to minimise the disadvantages of both methods. It is also possible to increase triangulation opportunities so that the results are more reliable and valid. The interview is better for handling more difficult and open-ended questions, (Oppenheim 1992), whereas the questionnaire is better for fixed response questions. Both take a lot of time – for the questionnaire this is in its initial set up and trialling, and for the interview in its individual (or group) interaction with the interviewer and the analysis of the results.

The study also intends to investigate the effect of layering the unit. Instead of working with a topic area to its full conclusion before moving on to another topic area, the layering system deals with a topic at basic level initially, then revisits it later in the course at a higher level, and so on. This means looking at comprehension against recall, (i.e. what can be applied correctly in a variety of situations; as well as what can be remembered or listed; as separate issues) and attainment (i.e. the final overall attainment). In order to address these issues, comparisons over time will be required. The important comparisons are the results prior and post exposure to a VLE resource and the pre and post 2002/03 standards. Prior to the VLE resource students had limited access to suitable resources. This study needs to investigate whether having this extra resource has any effect on overall achievement, as students can now "re-visit" topic areas more readily. Also the change of focus in grading criteria pre and post 02/03 has targeted a much broader base of knowledge as a minimum requirement. The overall effect of this also needs to be investigated. This is best suited to testing techniques. As the syllabus is criterion referenced, the testing is also criterion referenced. This automatically indicates exactly what a student can do and whether they have the ability to link these skills to what they have learnt in other contexts. However, this data is also used in a norm referenced way in terms of national bench marking to discriminate between students and their achievements.

Engineering First, Mathematics Second is an area for further study at a later date. This will aim to use mathematics as a tool within engineering contexts so that it is applied rather than theoretical. All of the topic areas will be linked into the appropriate engineering modules where they are applied so that there is dual access – from engineering to mathematics and vice versa – so that a student can readily swap between the disciplines of mathematics and engineering. This is intended to make the mathematics more accessible and relevant thereby improving student understanding and application.

5.4.1 Questionnaires

Using questionnaires enables a lot of information to be collected from any number of people in a short space of time. Once the questionnaire had been designed, piloted and amended, it was used on a continuous basis with different groups during the period of the research.

5.4.1.1 Introduction to Questionnaire Design

The difficulty with questionnaires is mainly in the design. Care must be taken to avoid all of the following:

- ambiguity, imprecision, assumption
- tests of memory
- tests of knowledge
- double questions
- leading questions
- presumption
- hypothetical scenarios
- offensive/sensitive questions
- poor appearance and layout
- too many open questions. (Bell 1999, Wellington 2000).

Wellington (2000) continues by adding that it is essential to design the questionnaire with the final analysis in mind.

Questionnaire design is another area where there is a consensus of opinion. All the literature emphasised the use of pilots to help with rephrasing questions, adding in categories, ensuring people would understand the questions, creating a good layout and sequencing the questions appropriately.

Oppenheim (1992), however, had the most detailed information about the initial planning of questionnaires and the styles of questions that could be used. His recommendations combined with the information from Cohen, Manion and Morrison (2000) will be used to produce the pilot questionnaires.
Oppenheim (1992) advises that closed questions with checklists are better for recall whereas open questions are better for opinions and feelings. Questions should be short, with no more than 20 words, all of which should be familiar. Only questions that are needed should be asked or included. He strongly recommends including "Don't know" and "Not applicable" categories.

When considering attitudes, then scales are the best option. The three major scale types are Thurstone, Guttman and Likert, (Oppenheim 1992).

5.4.1.2 Methods of Questionnaire Design

Oppenheim (1992), Fontana and Frey (1998), Bell (1999), Wellington (2000) and Cohen, Manion and Morrison (2000) all emphasise a set of nine points to bear in mind when designing a questionnaire:

1. Include a covering letter explaining the research and detailing confidentiality and other ethical issues.
2. Make sure all instructions are clear – maybe by using a different font style or use of capital letters.
3. Keep the layout simple to follow and clear.
4. Everything has to be legible and readable for your target audience.

5. The type face should be conservative.
6. Questions should be carefully sequenced.
7. Open forum should be included at the end for the respondent to put in any comments.
8. Always conclude by thanking the respondents.
9. Always pilot the questionnaire to find its faults.

According to Oppenheim (1992), there are five areas to consider when planning questionnaires. These are listed below.

1. Type of data collection instruments.
2. Method of approach to respondents.
3. Build-up of question sequences.
4. Order of questions.
5. Type of question.

Guttman scales look at attitude change through a hierarchical structure. They are reproducible using scalogram analysis, but the procedures are laborious. The scale is ordinal and cumulative so that the score relates to specific responses, not just any response. Consequently the scores have to be tabulated and coded according to the results obtained. These are then compared to the expected results.

Thurstone scales look at group differences. The students would have to put a series of pre-constructed sentences into 11 separate groups according to their feelings about each sentence. The sentences would then be numbered according to the chosen group for each individual student.

Likert scales can be applied to attitude patterns and theories of attitudes. They would be easier to work with than Thurstone scales, but correlate with them. The raw scores would be taken by scaling either individually or as an overall total. Evidence gathered by Oppenheim (1992) suggests that the reliability of these scales has a correlation coefficient of 0.85 when internal consistency is used in item selection (Oppenheim 1992, page 200). The pattern of responses would be more important than the individual scores. They would be easier to construct, provide more precise information and could even be used for items which were not obviously related. A scale of 5 would usually be used ranging from "strongly agree" through to "strongly disagree", or vice versa. The scales are uni-dimensional in that they only look at one thing at a time. They can be reliable if their consistency is very strong, but their validity is difficult to assess. They can be assumed to have linearity in that the intervals are equal or appear equal in order to make scoring possible and they are reproducible.

5.4.1.3 Conclusions for Questionnaire Design

Based on all of the above, a questionnaire will be needed to elicit a large amount of information from a reasonably large sample. It will need to be easy to complete, but also reliable in that "guessed" or "dishonest" answers could be eliminated, as described by Sudman and Bradburn (1982), and referenced in Cohen, Manion and Morrison (2000). This would be achieved by asking the same question in different ways at different points in the questionnaire. Also, by including other evidence to triangulate the responses - such as the computer observation log - responses can be double checked. The questionnaire also needs to track changes over the academic year as the students' progress through their course. Oppenheim (1992) concludes that a "before and after" questionnaire produces a more accurate picture. This is further enhanced if the change is scored by individuals, rather than the overall distribution. Consequently, it was decided to use three separate questionnaires, administered at the start, midpoint and end of the course. Following the recurring comments from the literature it was decided to keep the writing style consistent over the three questionnaires, and several of the questions would be repeated on each of the questionnaires. The questionnaires used a variety of techniques to elicit the information required. These techniques are described in detail in Chapter 6.

Looking again at Oppenheim (1992), some of the issues that arise within the five areas to consider when planning questionnaires are listed below.

1. Group administered questionnaires would be best for this study although contamination through copying, talking and asking questions needed to be avoided.
2. An increased response rate could be achieved by giving advance warning, explaining the method of selection, assuring confidentiality and anonymity, the questionnaire having a good appearance of reasonable length and the topic being of some degree of interest to the participants.
3. There needed to be a balance of question types. The questions were better set up in a series of sections, but had to follow the logic of the inquiry. Also any reaction to the questions had to be considered.
4. There needed to be filtering questions with routing instructions so that irrelevant questions did not have to be answered. The questions also needed to funnel from a broad scope to specifics.

5. There should be mainly closed questions with choices of answers. These could be simple yes/no or several choices. These would be quicker and easier to answer because they required no writing. Quantification would be straightforward; group comparison would be easier and very useful for testing specifics. However, there would be a loss of spontaneity and expression, there might be bias in the answer categories, the choices might be too basic and they might irritate the respondents. To be sure of answering, it is always a good idea to include the category “Other” with “please specify”.

From this it was clear that open questions should be kept to a minimum, but still included. This would give the respondents the freedom to express their own ideas, which might be of value for research ideas or awareness. However, these answers would be difficult to analyse as they would require coding frames and these would be time consuming to construct.

Guttman scales were considered too complicated for this study, whilst Thurstone scales would be very time consuming and many students would not do this willingly. Consequently, of the three types of scale Likert would seem to be the most appropriate. It would be the easiest of the three to get the students to complete, and could be used at different times to check for any attitude changes over the year.

5.4.2 Interviews

Interviews are another method for gaining a lot of data. Interviews can be very time consuming, but there is more scope than in a questionnaire.

5.4.2.1 Introduction to Interview Design

The questionnaire gives fixed replies, but with little chance for development. By following this up with an interview it is possible to develop answers obtained from the questionnaire and get more in depth information.

5.4.2.2 Methods of Interview Design

Interviews can be structured, semi-structured or unstructured. Oppenheim (1992) and Keats (2000) look at this in detail, and their views are supported by both Bell (1999) and Wellington (2000). The structured interview is more easily controlled by the interviewer, who has a predetermined agenda. Because the agenda is already set, the outcomes can more readily be analysed by use of a framework. However, this type of structured interview is less flexible because of these constraints. At the other extreme, the unstructured interview is very unpredictable because it can be controlled by the interviewee. This makes it very difficult to analyse, but very flexible.

Unusual responses can be followed up by individual interviews, but otherwise a representative sample will be taken from the group for group interviews. As the interview is usually directed to a smaller sample than a questionnaire, this automatically gives a limited number of responses. Due to the sample size, the overall reliability is limited, according to Tuckman (1972). Reliability could also be influenced by repetition of the same interview with different people at different times, possibly with a different interviewer, and the emphasis of the interviewer. However, Cohen, Manion and Morrison, (2000), agree that in conjunction with the questionnaire data this unreliability is minimised.

Interviewing individuals is very time consuming, but it allows an examination of reasons behind changes of attitude and perceived ability which cannot be gathered from the questionnaire alone. With regard to the VLE resources, however, group interviewing would be a very useful technique as it can impact less on an individual student's time. This is because by using groups from the individual classes, there is no need for the individuals to be in College on extra days or outside of normal hours – they can just be collected from normal classes for short intervals where necessary within the normal working week. This is a particularly important factor for day release students whose opportunity to attend College is very limited. If the group interview takes the form of a focus group this not only gathers feedback from previous experiences but also enables triangulation with individual interviews and questionnaires. Cohen, Manion and Morrison (2000) relate this back to both Morgan (1988) and to Krueger (1988), and the same point is raised in Oppenheim (1992), Fontana and Frey (1998), Bell (1999), Wellington (2000), Keats (2000) and Walford (2001). The focus group relies on the interaction within the group as they discuss the given topic. Although the setting is unnatural it is highly focussed and consequently produces a large amount of data from the interaction in a short time.

Fontana and Frey (1998) sum this up in Denzin and Lincoln (1991) by describing focus groups as:

> *"Inexpensive, data rich, flexible, stimulating to respondents, recall aiding, cumulative and elaborative."*
> (Page 55).

However, group interviews are not without their disadvantages. The number of focus groups must be greater than one so that uniqueness is avoided. The group size must not be too small otherwise the dynamics will have a disproportionate effect, but it must not be too big as the group becomes hard to manage and fragments. The meeting must be chaired so that it is kept open-ended, and ‘to the point’ as the participants should all be made to feel that they have something to say and be prepared to say it. Sampling is the major key to success and an allowance of up to 20% should be made for a “no show” scenario, (Cohen, Manion and Morrison 2000, Wellington 2000).

The same problems with interview questions occur as for questionnaires. Double-barrelled (i.e. one question which is actually two separate questions), two-in-one, restrictive, leading and loaded questions have to be avoided. The sequence has to be right and make sense. However, there are also some problems which are unique to the interview situation. These relate to recording the interview and taking notes. Wellington (2000) summarises Nunan’s list (1992) into points for and against. This is listed below.

Advantages for recording are:

1. The original sentence structure and language is unaltered.
2. The process is flattering for the interviewee.
3. The record is totally objective.
4. The interviewers input can also be assessed.
5. The interviewer is free to maintain good eye contact, observe body language and concentrate on what is being said.

Disadvantages for recording are:

1. An enormous amount of data is produced.
2. Very time consuming to transcribe.
3. The context is not recorded.
4. The machine can create anxiety in some interviewees.
5. Core issues can be masked by irrelevancies.

Advantages for taking notes are:

1. Only central issues or facts are recorded.
2. It is more economical with respect to time.
3. Off record statements are not noted.

Disadvantages for taking notes are:

1. Possible recorder bias.
2. It may be distracting for the interviewee.
3. Encoding could interfere with the interview.
4. Results of interview would be difficult to verify.

According to Keats (2000) it is a sensible idea to examine the structure and pattern of the interview afterwards to check for sources of bias, any problems with probing and to help with remembering complex interactions. This is more efficiently done if the interview has been recorded. This also allows “office coding” to take place, (Oppenheim 1992). Office coding refers to the situation where the recorded responses are taken away and coded via a worked out coding frame. With this it is possible to re-code if necessary as the original data remains largely intact, but gestures and facial expressions are lost. It also allows for reliability checks to be conducted, but is more time consuming than coding “on the spot”. There is an inevitable loss of information by using coding, but it is the best way to analyse the results. Good piloting helps to minimise these problems. However, the effectiveness of the interview is also dependent on how the interviewees respond and how good the interviewers’ skills are at interpreting the situation. Great care has to be taken to avoid bias and ambiguity and to avoid giving non verbal cues. This is attributable to the empathy the interviewer has with the interviewees and to their professionalism.

Several of these problems can be overcome by good piloting of the interview and good sampling for choosing interviewees.

5.4.2.3 Conclusions for Interview Design

The ideal would be to have an interview guide, which is an outline of questions that need to be answered, but with the flexibility to ask additional follow up questions. The more open ended the questions, the more information it is possible to obtain. Also the use of probing techniques, such as "tell me more ..., please clarify …" rather than prompting would allow for more in depth information to be gathered reasonably easily. This is one of the main advantages that an interview has over a questionnaire, as described by both Keats (2000) and Wellington (2000).

If the interview was addressed towards a small group it would be possible to obtain more data from their interaction about the questions being asked. By using a small group, there is a better chance of getting each individual to contribute. Long silences tend to be filled automatically, so the less individuals to fill the gaps, the more data they will give openly. As the questionnaires would already have been used to analyse the information, a focused interview would be the best follow up. The interview guide would be based around this information. This fits well with Morton and Kendall's view (1946) that the interviewees would all have been involved with the intervention, and their subjective experiences would be the main focus, (Cohen, Manion and Morrison 2000).

For this study the most suitable method seemed to be a focus group interview towards the end of each academic year. The sample would need to be taken from students who agree to be interviewed at the start of the year and who are still in agreement at the end of the year. To try to avoid bias a sample group from each of the individual classes should be taken. The choice is between taking a representative sample or a random one. A random sample could bring some unusual points to light, but this could also be clear from the questionnaire results, whereas the groups' dynamics could be more clearly captured by a representative sample. So, a representative sample would seem to be more sensible. The interview would be semi-structured, with key questions to be answered, but allowing flexibility to follow up comments from the group interactions. The interview would be recorded, with the consent of the interviewee. If this was not given, then notes would be taken of the interview instead. Office coding would then be employed to analyse the responses. Following on from this it would still be possible to interview individual students to gain a deeper insight into emerging threads, and to focus on particular aspects arising from the research questions. Investigating other related information, such as the management's rationale behind the VLE and its implementation, is also suited to interviewing techniques. These interviews would need to be targeted towards specific individuals within the College who have an appropriate knowledge and level of involvement with the operation and installation of the VLE system.

5.4.3 Use of Predictors

Predictors are a method of analysing past academic performance and predicting a final level of achievement based on this prior performance. It is used to determine whether a student has the ability to achieve success. It does not take into account their aptitude for varying subject areas, nor does it take attitude as a measure. The starting point for achievement is the historical records of students' results as recorded by the examining body. This just gives a raw grade with no indication of an individual student's problem areas or strengths. These results come from the individual results over a series of tests which cover the syllabus. There is no indication of the individual results, only the overall outcome.

All results post 2002/03 are subject to the new style of criterion referenced grading. A criterion referenced test does not compare students against each other. Instead the student has to fulfil a given set of criteria which are predefined. The criteria are an absolute standard which have to be met in their entirety to obtain the learning outcome, according to Cunningham (1998) as stated in Cohen, Manion and Morrison (2000).

This indicates more clearly what individual students can and cannot do. However, it does not indicate whether grades obtained are due to attitude or ability, or both. Students' entry grades would be a useful indicator here. In the final pre-VLE version of the questionnaire, it would seem a sensible idea to add this as an introductory question, so that the data would then be available for all students who were prepared to fill it in.

5.4.4 Computer Usage Logging Systems

Additional information about VLE usage can be obtained from the system itself. As well as validating student questionnaire responses, the tracking facility of the VLE would allow for further analysis on the number, duration and frequency of usage for each of the different lessons available. This data was very easy to obtain as it was already available as part of the system. The tracking facility would be easier to implement than getting students to complete log books, and would also be more reliable in the information that it gave. However, as each individual set of information within the VLE resource would need to be checked for each individual student, this would be a laborious task for the researcher. Sampling techniques may be necessary to overcome this if it proves to be too time consuming.

5.5 Summary

This chapter has outlined the possible research methods available and discussed the viability of each method with regards to the proposed study. From this the overall methods were individually considered, with a case study approach being regarded as the most suitable. The data collection methods were then considered, and the final choices of methods were to use a mixture of questionnaires, interviews, examination results and computer usage logging systems.

CHAPTER 6

DEVELOPMENT OF RESEARCH TOOLS

6.1 Introduction

This chapter details the development of the research tools, and how they link back to the research questions. It begins with the questionnaires, moves on to the interviews, the computer logging system and result collections. The design aspects of the questionnaires and interviews will be described. The amendments are discussed, together with any further alterations and additional data gathering techniques that these may instigate. The final live versions of the questionnaires and interviews can be found in Appendix B, sections 2 and 3.

6.2 General Issues

From Chapter 5, the ideal research tools for the proposed case study were identified as questionnaires, interviews, testing and the computer logging system. The main problem was how to put these tools together in order to answer all of the questions for the research aims. The overarching question *"Does the use of a VLE enhance student learning of mathematics?"* is very vague, and needs to be broken down into the separate parts in order to be fully answered.

It is important to know whether the VLE enhances, but also, if it does – how it actually does this. The two main thrusts of the question apply to the resources available through the VLE and the layering effect of the topic areas.

		Questionnaire	Interview	Computer Logging System	Testing
How VLE resources are used	Where	√	√		
	When		√	√	
	By whom	√	√	√	
	What	√	√	√	
	How frequently	√	√	√	
	Duration	√	√	√	
	Ref ILT Strategy	√	√	√	
Viability of VLE	Financial set up		√		
	Ease of use	√	√		
	Preparation time		√		
	Ref ILT Strategy		√		
Learner's experience	Usefulness	√	√		
	Why	√	√		
	Meets expectations	√	√		
	Effect on attitudes - Mathematics	√	√		
	Effect on attitudes - ICT	√	√		
	Ref Learner Policy	√	√		
	Ref ILT Strategy	√	√		
College policies	Improved success				√
	Improved retention				√
	Improved achievement				√
	Improved figures				√
Layering	Comprehension v recall		√		√
	Final attainment & results	√	√		√
College results	Pre VLE resources				√
	Post VLE resources				√
	Previous standards				√
	Current standards				√

Table 6.1: Initial Checklist for Research Tools

	How VLE resources are used	Viability of VLE	Learner's experience	College policies	Layering	College results
Individual staff interviews	√	√		√		
Individual student interviews	√	√	√	√	√	
Group interviews of students	√	√	√	√	√	
Questionnaires	√	√	√			
Computer logging system	√			√		
Results from staff				√	√	√
Results from exam boards				√	√	√

Table 6.2: Summary of Areas for Research Tools

Once it is known where evidence is automatically available, then the research tools can be designed to focus on other areas of evidence that are required. This will ensure that there is a broad base of evidence which is triangulated. By drawing up a table of possible methods, then a clear way through can be seen. It will be important to triangulate as much information as possible, so to collect the data by several means is important. This initial checklist is shown in Table 6.1. From Table 6.1, the areas for each of the tools can be determined, and from this the actual methods to be included can be decided, as summarised in Table 6.2.

As well as considering the design of the research tools, it is also important to consider who will be asked to complete the questionnaires, interviews, etc. The majority of the information needs to come from the students, with some additional information from staff and the computer logging system. The VLE allows tutors hidden access to view individual student use of resources. The students are not aware of the monitoring, so it can not have any affect on what they do. Information from staff about the system and their knowledge about this is subject to their agreeing to take part in the study. Information about student results from staff would normally be available through examination boards meetings to the course team, but to be able to use the information it will be necessary for permission to be obtained from the Principal. At the same time, permission will be sought to undertake the full study, which means that access will also be given to speak to and gather information from the students.

Initially all students from the engineering intake will be targeted. However, they will all be asked to complete a form of agreement before being involved with the case study. The agreement will split into two parts – firstly to agree to complete the questionnaires, secondly to agree to take part in interviews, if asked. Both parts have to be signed and dated if they are in agreement to taking full part. There will be no pressure for them to take part in any or all of the case study.

There will also be a disclaimer which gives them the option of changing their mind at any time and withdrawing from the study. Before signing any of the forms the full details of the number of questionnaires and forms of interviews will be explained, and questions will be encouraged. They will be advised that this is a case study research centred on both their mathematics unit and the College VLE. This will be given as an overview rather than in any great detail, as it is important not to influence the outcomes.

In order to establish an academic baseline for the subjects it will be necessary to establish the entry qualifications (if any) for each subject. Not all qualifications are relevant, so a simple listing of suitable data with alternatives will be given for the students to complete by ticking boxes. Grades and dates will be useful here. This information will only be required at the start of the year. To keep the interruptions to the groups minimal it would be sensible to include this with the first questionnaire.

6.3 Questionnaire Design

The questionnaire was intended to be administered at three separate times during the year. This meant that the three questionnaires had to have a similar style and layout, even if different questions were asked. Clearly, some of the questions would need to be repeated on all three questionnaires so that comparisons could be made. The three questionnaires would need to be pre VLE usage, around the start of the course in September, mid VLE usage, around February, and post VLE usage, around June, all in the same academic year. Before designing the questionnaires, it was necessary to think about what questions needed to be answered in order to fulfil the aims of the research, as emphasised by Wellington (2000).

The questionnaires needed to look at both the ability and the attitude of the students, from the student's viewpoint, towards both mathematics and ICT. This was to get a students perspective on how they felt about both subject areas. If they found mathematics easy, but got little enjoyment from it, then they were less likely to use the resource than another student who was struggling. Also, they needed to be able to access the VLE resources, which hinged on some ability in using ICT. It also gave an indicator as to their confidence, as a prior grade did not necessarily reflect how they saw their abilities. As the intention is to provide another resource, methods of reviewing topics and catching up work were also considered.

6.3.1 Styles of Questions

The basic intention with the questionnaires was to take snapshots of the students' attitudes and feelings with regards to mathematics and ICT, and their usage (if any) of the mathematics lectures posted on the VLE. This would give a good general background to the students before looking deeper into the research questions. By looking at their attitudes and feelings this would give an indicator as to how comfortable the students were with these subjects, and how they viewed themselves with regard to others in their group. This could be crucial to their final achievement, and to how they fitted into the group. The better they fitted into the group the more likely they would be able to work together, which would help with their studies. The use of Likert scales would be the most appropriate method for this as explained by Oppenheim (1992), and as discussed in Chapter 5.

As the mathematics resource on the VLE was intended as a support for students, not all of the students are likely to use it. Consequently, it would be useful to know what sort of support (if any) students are prepared to use. A tick box listing of alternatives would be useful here, with a space for "Other, please specify". This will need to be on the pre VLE questionnaire. The other two questionnaires will need to follow this up by asking what support strategies (if any) are used. The mid and post VLE questionnaires will obtain data about what (if anything) is accessed via the VLE. The where, when, how often, how long and why, will also need to be addressed within this section. Tick box options will make the choices easier to make and to code, as described in Oppenheim (1992) and as discussed in Chapter 5.

To route between different sets of questions it would be useful to use dichotomous questions with Yes/No answers. This would allow students to miss out sections that are not relevant to them. This would mean that only relevant information is gathered and the students would be more likely to complete the questions properly as opposed to trying to rush through large amounts of information. This was also discussed in Chapter 5.

Further information about the resource – whether it is easy to use, any problems found, whether it is useful, whether it is what they expected – would also need to be asked. Some of this would have to be through open questions, which might be explored further in interview questions later. Cohen, Manion and Morrison (2000) found that there was a problem both with the coherent answering and the length of time required to answer open questions. These questions will have to be carefully placed with the requirement of a sufficiently small reply so that the students will be more inclined to complete them. It can often be difficult to compare answers, however, which will cause some problems in data classification and analysis. However, the extra richness of information that could be obtained in this way should make it a useful addition in the overall questionnaire.

6.3.2 Question Content

The question content needs to fully cover all the areas of the research questions as highlighted in Table 6.1. There also needs to be diversity in the questioning methods so that the same questions can be asked in different ways to double check the validity of answers given. In order to do this, the appropriate parts of Table 6.1 were picked out and the questions focussed at each area were considered. The overall results of this breakdown can be seen in Table 6.3. This breakdown is based on the final version of the questionnaires, rather than the various pilot and trial versions, and can be found in Appendix B, section 2.

How VLE resources are used	Where	4 & 8 tick box options Likert scale of 4 Dichotomous choices
	By whom	Identifier
	What	Min of 20 tick box options
	How frequently	Likert scale of 4
	Duration	Likert scale of 5
	Ref ILT Strategy	Open questions
	Ease of use	4 tick box options Dichotomous choices
Learner's experience	Usefulness	Yes/No/Don't Know + reason
	Why	Open questions
	Meets expectations	Yes/No/Don't Know + reason Open questions
	Effect on attitudes - Mathematics	Likert scale of 7
	Effect on attitudes ICT	Likert scale of 7
	Ref Learner Policy	Likert scales of 4 & 7 7 & 8 tick box options Dichotomous choices
	Ref ILT Strategy	Open questions
Layering	Final attainment & results	5 & 6 tick box options

Table 6.3: Questionnaire Content by Research Questions

Some of the dichotomous questions were extended to give an option of "Don't Know". All of these had the option to include a reason, which was clearly asked for. Some of the Likert scales were numerical, and some were worded, depending upon what was being measured. The tick boxes varied according to possible choices available and allowed open questions to be used more appropriately for finding out more complex information.

6.3.3 Split of Questions

The questions were split across the 3 questionnaires to provide tracking of changes and triangulation. Many of the questions were the same across the questionnaires. Those that were not repeated exactly were triangulated; mainly with other questions within the same questionnaire, but sometimes across questionnaires. The full list of the corresponding questions across the three questionnaires is detailed in Table 6.4.

Pre VLE	Mid VLE	Post VLE	Methodology
1	1	1	Tracking Changes
2	2	2	Tracking Changes
3	3	3	Tracking Changes
4 & 11			Triangulation
5 & 12			Triangulation
6	10	15 (17)	Tracking Changes & Triangulation
7	5 & 4, 15, 16	29	Tracking Changes
8		26	Triangulation
9 & 19			Triangulation
10		28	Triangulation
11 & 4		25	Triangulation
12 & 5		27	Triangulation
13	4 & 5, 15, 16	4	Tracking Changes
14	17	8	Tracking Changes
15	18	9	Tracking Changes
16	19	10	Tracking Changes
17	20	11	Tracking Changes
18	6	24	Tracking Changes
19 & 9		23	Triangulation
20	7	(12, 13)	Triangulation
	8	14	Triangulation
	9	6	Triangulation
	11	14	Triangulation
	12	5	Triangulation
	13	22 & 21	Triangulation
	14	30	Triangulation
	15 & 4, 5, 16		Triangulation
	16 & 4, 5, 15	7 & 31	Triangulation
		16 & 18, 19, 20	Triangulation
		18 & 19, 20, 16	Triangulation
		19 & 20, 16, 18	Triangulation
		20 & 16, 18, 19	Triangulation
		21 & 22	Triangulation
		31 & 7	Triangulation
( ) indicates questions that differ slightly from the main question indicated			

Table 6.4: Split of Questions across Questionnaires

The table shows that all questions were either tracked or triangulated, or both.

Pre VLE Questionnaire

The pre VLE questionnaire was to gain a basic background to all areas of ability, attitude, support methods, strategies and the possibility of using internet resources. The first three questions, questions 13 – 18 and question 7 look at both ability and attitude to both ICT and mathematics. Questions 4, 5, 8 – 12 and 19 target support methods and support strategies. The VLE resources were not specifically mentioned, but hinted at by use of internet resources and lesson reviews. These were indicated by questions 6 and 20. There were a total of 20 questions with all questions needing answers.

Mid VLE Questionnaire

The mid VLE questionnaire was based on the pre VLE questionnaire. The first six questions revisited the attitude and ability indicators from the first questionnaire, as did questions 17 to 20. The seventh question became the choice question in that the reply predetermined the rest of the route through the questionnaire.

Have you used or looked at Blackboard mathematics lessons?

Yes *No*

Please give reasons for your choice of answer:

…………………………………………………………………………..

…………………………………………………………………………..

If you answered YES to 7(b), please continue from question number 8.

If you answered NO to 7(b), please go straight to question number 14.

Questions 8 to 13 specifically target questions about using VLE resources whereas questions 14 to 16 look at which topics required support and the strategies employed. There were a total of twenty questions with a maximum of seventeen requiring replies.

Post VLE Questionnaire

The post VLE questionnaire was based on both the pre and mid VLE questionnaires. Questions 1 to 4 and 8 to 11 re-examine attitudes and ability, questions 5 and 6 look at the use of the VLE resources and question 7 looks at support strategies. The twelfth question becomes the choice question in that the reply predetermines the rest of the route through the questionnaire, as question 7 did in the mid VLE questionnaire. Questions 13 to 21 specifically target questions about using the VLE resources whereas questions 22 to 30 look at other support strategies employed. The twentieth question is a specific open question targeted at using the VLE resources, as below.

What do you feel are the benefits and problems associated with Blackboard mathematics lessons?

Benefits	*Problems*

There were a total of thirty questions with a maximum of twenty two requiring replies. The three questionnaires together built up a picture over the year of any attitude and perceived ability changes, and can be viewed in the light of unit results and methods of support. They also gave feedback on the good and bad points of the VLE resources, together with an evaluation of what can be improved. The questionnaires also highlight which specific topic areas cause most problems to the students, or require more time spent on them.

6.3.4 Final Versions

The first questionnaire needed to be issued at the start of the academic year. This also needed to include the agreement paperwork and the grades information sheets. As these were only used initially, they were kept separate from the main questionnaire.

Different points scales were used in the initial studies and the pilot and the most appropriate for the individual questions were used in the final study. These questions needed to be repeated on all three questionnaires to check for any changes of opinions over the year. However, it seemed a good idea to split them up so that they were in small bundles on similar subjects. A Likert rating scale will be used with discrete categories to gain a subtlety of response. In some cases a semantic differential will be used in that an adjective is placed at each end of the scale with numeric values.

How do you feel about mathematics?

I intensely dislike mathematics						*I intensely like mathematics*
1	*2*	*3*	*4*	*5*	*6*	*7*

This allows for a freedom of response which allows measurement to merge with opinion. By providing a scale of values, without any wording, the students will be able to put their own personal rating values against the numbers, based from the two extremes. The choice of numbers rather than a continuous line gives a measure of their opinion as they will tend to circle a specific value or number. There is no assumption of equal intervals, or checks on the truth of statements, or alternative responses. However, some questions are going to be repeated in an alternative form to double check the validity of the answers. A larger scale is used in some of the questions to avoid the problem of respondents avoiding extremities. There were several dichotomous questions originally, requiring yes/no responses.

Do you think it is possible to learn mathematics via the Internet?

Yes *No*

These were useful for ensuring a decision was made, and were also be used as routing instructions to direct the student to questions of relevance to them. In the mid and post VLE questionnaires these led on to a separate set of questions, appropriate to the chosen reply. There were also multiple choice questions which required a single tick box response or questions which required multiple tick box responses. These gathered information which mainly had preset responses or responses that were normally to be expected. There also needed to be an option for "other" which invited further explanation.

6.4 Interview Design

The interviews were aimed at the collection of more in depth information from selected individuals and groups to address the research questions. There needed to be a variety of interviews, each targeting a slightly different aspect of the research. From the discussions in Chapter 5 the chosen methods were group student interviews as described by Fontana and Frey (1998) in Denzin and Lincoln (1991); followed up by individual student interviews as detailed in Oppenheim (1992), Bell (1999), Keats (2000) and Wellington (2000); and staff interviews as discussed in Keats (2000) and Wellington (2000). This meant that there were be three forms of interviews needed. The first (group) interview was to gather more information to help triangulate the questionnaire responses, and to collect verbally the responses the students were not prepared to write in response to the open question replies. The second (individual) interview were needed to specifically address the research questions by digging deeper into the responses already obtained and getting reflections from the students concerned. The third (individual) interview also needed to specifically address the research questions by getting reflections but was also a data gathering tool targeted at the individuals responsible for buying in, setting up and maintaining the overall system as well as the day to day running of the system. This third interview was specifically aimed at individual managers and appropriate members of their staff within the college.

6.4.1 Group Interviews

The group interviews looked again at the use of the resources and the viability of the VLE. The learner's experience was a key factor within this set of questions. The focus of the questions was quite different to those of the questionnaires as it picked up on ability, the resource and its usefulness. Within this it was also possible to investigate and triangulate the use, learners experience and other variables as well, such as comprehension and recall. The research areas under investigation within this interview are shown in Table 6.5.

All students were given a choice as to taking part in the interview process. The groups were selected by teaching group initially. This meant that every teaching group had an input to the group interviews. Within each teaching group a set of 4 individuals was selected from the possible interviewees. This was to ensure that at least 2 – 3 students took part for each group discussion.

The mix of the teaching group was considered when choosing the interview groups. The group was specifically chosen as a representative sample, rather than by whether they had accessed the VLE resources or not.

How VLE resources are used	Where	√
	When	√
	By whom	√
	What	√
	How frequently	√
	Duration	√
	Ref ILT Strategy	√
Viability of VLE	Ease of use	√
	Ref ILT Strategy	√
Learner's experience	Usefulness	√
	Why	√
	Meets expectations	√
	Effect on attitudes - Mathematics	√
	Effect on attitudes ICT	√
	Ref Learner Policy	√
	Ref ILT Strategy	√
Layering	Comprehension v recall	√

Table 6.5: Group Interview Areas by Research Questions

The interview aimed to identify any items of interest from the questionnaires. It also aimed to establish the views of the students with regard to the VLE resources. Here the issues are not just the content of the lectures, but also any problems that have occurred with the system. If the system is to be of any use it must be easily accessible to all students, and the contents must be suitable for them. These areas had to be explored. Other than this there were also a few strategic questions that need to be asked during the course of the interview, as outlined below. The first area to be explored were the students' perceived abilities in mathematics and ICT.

Over the year do you feel that your ability in mathematics has changed?

The next area to be targeted was the lectures that were available through the VLE resources. These needed to be addressed according to the mix of the group being interviewed.

> Mixed – *Why did/didn't you use the lessons?*
>
> Users - *What do you feel you got from using the lessons?*
>
> Non users - *What were you expectations of the lessons?*

The responses were to be the starting points of the interactions between the members of the group, to establish agreements and disagreements and opinions. Once the focus has been brought onto the VLE lectures, it was important to find out how the students perceived these.

> *Focusing on the technology and the format of the lessons, please describe a good/bad session you have had using Blackboard mathematics lessons.*

For the non user group the other support strategies that had been employed needed to be explored instead.

Also, obtaining some idea of the time spent using the software was useful before individual's records from the computer tracking data were looked at. It also gave an idea of any computing problems or navigation failures.

> *How did you spend your time?*

Finally, it was useful to obtain general feedback from the groups, as they were more likely to provide information in the group when they were not targeted individually.

Do you have any other comments, or anything else that you would like to add?

6.4.2 Individual Student Follow-Up Interviews

The individual student interviews were used to look more deeply into the research questions. The interviews also looked again at the use of the resources and the viability of the VLE. The learner's experience was a key factor within this set of questions. Although the research areas were unchanged, as shown in Table 6.6, the focus of the questions was quite different to those of the group interviews, as shown in Table 6.5 earlier.

How VLE resources are used	Where	√
	When	√
	By whom	√
	What	√
	How frequently	√
	Duration	√
	Ref ILT Strategy	√
Viability of VLE	Ease of use	√
	Ref ILT Strategy	√
Learner's experience	Usefulness	√
	Why	√
	Meets expectations	√
	Effect on attitudes - Mathematics	√
	Effect on attitudes ICT	√
	Ref Learner Policy	√
	Ref ILT Strategy	√
Layering	Comprehension v recall	√
	Final attainment & results	√

Table 6.6: Individual Interview Areas by Research Questions

This set of questions arose from the themes that were apparent from the questionnaires and earlier interview data. The start was a further triangulation of earlier responses, but then the questions linked directly to the themes arising from the research data and the original research questions.

- How does a virtual resource compare to the real classroom situation?
- How do you rate the Blackboard/Moodle resource in terms of mathematics support on a scale of 1 to 10, with 1 being poor and 10 being good? Why?
- Does your employer have access to the virtual resources? Is it/would it be useful for them to have access? Why/not?

There were a lot of questions and they all required some thought, once past the initial triangulation phase.

- Has the mathematics you have learnt on this course been applied in any other subject areas or your work place? How has it been applied, and why?
- What is the College virtual learning environment used for?

The final live version of the individual student interview questions can be found in Appendix B, Section 3.

6.4.3 Individual VLE Management Personnel Interviews

The staff interviews also looked again at the use of the resources and the viability of the VLE. However, although the research areas were unchanged, as shown in Table 6.7, the focus of the questions was quite different to that of the students.

How VLE resources are used	Where	√
	By whom	√
	How frequently	√
	Ref ILT Strategy	√
Viability of VLE	Financial set up	√
	Ease of use	√
	Preparation time	√
	Ref ILT Strategy	√

Table 6.7: Managers' Interview Areas by Research Questions

The interview questions needed for the College staff were very specific. It was important that they addressed all of the funding and resourcing issues together with the rationale behind the VLE.

The questions were formulated to address the research questions that the students could not provide data for.

- What were the initial financial set-up costs for Blackboard?
- What implications were there to the College computer systems in terms of upgrading?
- What were the benefits and disadvantages of the new system?

These interviews explored the College past, present and future requirements with regards to VLE resources and e-learning.

- Why was the system switched over to Moodle?
- What problems were encountered during switch over and how were they overcome?
- What are the benefits and disadvantages of the new system?
- Is it necessary to train staff to use the new system? What time costs are involved with this?

These had to be "one-off" interviews, so there was no possibility of pre trialling with equivalent individuals. There were a lot of questions, many of which needed reflection.

- How will this fit into the wider picture of a city-wide learning platform?
- What effect is this likely to have on future job roles for both IT support staff and lecturers?
- How viable is the resource for the future?

The final live version of the management personnel interview questions can be found in Appendix B, Section 3.

6.4.4 Final Versions

The group interviews were set up so that each main question, with prompts, was issued on paper to each of the participants prior to the start of the discussions. This allowed time for reflection by the individuals before the discussions began. This meant that there were few long pauses and that everyone was able to input information relevant to the questions being asked without the researcher having to continually interrupt or prompt. The interview broke down into five key questions – mathematics ability, ICT ability, use of Blackboard lessons, and good and bad Blackboard mathematics lessons.

The individual student follow-up interviews consisted of much shorter, in depth questions. This meant that the participants needed more thinking time, but there was not a need to give out the questions or continually repeat them. There were a total of 26 questions which covered the original questionnaire and group interview questions but focussed heavily on the why and what for. This was set up to elicit the reasons behind the answers given earlier.

The individual VLE management personnel interviews also consisted of shorter in depth questions. Due to the nature of the questions, it was either an area of expertise for the interviewee or not. In cases where it was not, the individuals interviewed were able to state this and suggest a more suitable person for that piece of information. Consequently, although only 2 staff were originally targeted for this interview, several other staff were also interviewed to gather the extra in depth information. There were a total of 43 questions which looked at the past, present and future systems and the possible implications both financially and otherwise. Within this the use by staff and possible training needs were also addressed.

6.5 Testing

As part of the College systems, all modules have to be completed according to the examining body requirements. The grade achieved is dependent upon meeting the agreed criteria for that module. Although the criteria and ways to meet the criteria have changed externally, the focus mathematically has always been the mixture of in class tests and assignments. (See Chapter 3 for more details about syllabi).

These final results have to be agreed by the examining body and are set at nationally agreed standards. Thus a Pass in one college is equivalent to a Pass at another college, elsewhere in the country. This means that it was possible to compare the final outcomes of the module against nationally set targets, as outlined in Cunningham (1998) and Cohen, Manion and Morrison (2000). The focus of the modules results linked with the research questions as outlined in Table 6.8.

College policies	Improved success	√
	Improved retention	√
	Improved achievement	√
	Improved figures	√
Layering	Comprehension v recall	√
	Final attainment & results	√
College results	Pre VLE resources	√
	Post VLE resources	√
	Previous standards	√
	Current standards	√

Table 6.8: Testing Areas by Research Questions

6.5.1 Old Syllabus Results

Looking at the past performances of students, prior to the introduction of the new syllabus, gave an overview of trends within each of the engineering groups and for the whole cohort. This gave a general baseline for comparison. The results for five years were considered to allow for any strange fluctuations that may have occurred with the data for any given academic year. There was no reason to pre-suppose that the students following the new syllabus were academically different from those studying the old syllabus. Consequently, a similar set of trends should have emerged for the new syllabus.

6.5.2 New Syllabus Results

The new syllabus results were much easier to collect as they were within the scope of the archived data. The initial results for the new syllabus were devoid of any VLE enhancements or use. This meant that there was also a base line for the new syllabus to be compared against. This allowed a direct comparison of new and old as well as a direct comparison of with and without VLE use. This data allowed trends and success rates to be produced for direct comparisons, and was readily available within group settings.

6.5.3 Retention, Achievement, Success Rates

The data produced from the module results clearly showed how many students started, finished, achieved and succeeded. This gave a clear indication of what was needed by the College for statistical purposes. It also showed whether the use of the VLE was helping to drive success rates upwards. The retention was calculated by taking the number of starters to finishers as a percentage. The achievement was calculated by taking the number of finishers to completers as a percentage. The success rate was then the multiple of the retention by the achievement as a percentage.

6.5.4 Benchmarking Government Targets

In recent years the government has set benchmark targets to check the progress and suitability of colleges to deliver courses. These targets are used to help decide what grade a college is performing at. To achieve the benchmark figure or a variance of 5% up or down is deemed as satisfactory (grade 3). Below this figure by more than 5% is deemed unsatisfactory (grade 4) and can mean closure or special measures. Above this figure by more than 5% is deemed good (grade 2) or outstanding (grade 1), according to the level of achievement beyond the 5%. Any college which continually gets grade 3's is classed as a "coasting" college and can have its funding withdrawn or drastically reduced. Consequently, the improvement of success rates is of great concern to the College management. The benchmarking is allocated by level and course of study, and not by individual modules. This means that a student could possibly pass a course without passing the mathematics module. Also the benchmarking figures are nationally set and increase each academic year. As this study was looking specifically at the mathematics module across the engineering groups, it seemed sensible to take the benchmarking figures for the individual courses which were applied to the mathematics module. This also gave a comparison of the expected success rates for each of the individual courses more clearly and helped to determine whether the mathematics module was affecting the overall success rates.

6.5.5 Prior Attainment Indicators

The prior attainment indicators are the skills sets that the student arrived at the College with. The measurable factors are examination grades. The age of this grade does impact upon the performance indicator value as syllabi vary over time. Also, if the grade is old and the subject matter has not been used in a while, the earlier performance of this individual is likely to be of a lower standard than later work by the same individual. As this study is focussing on mathematics, then the level of mathematics qualification will be taken as the key performance indicator. This will also help to provide information about comprehension as opposed to recall. Within the syllabi the way the grades are set up allows students to pass mainly by recalling methods and applications. For higher grades it is necessary to also demonstrate an understanding, or comprehension, of the applications of the methods. This is also demonstrated by the attainment indicators. The lower the level of indicator, the more likely the student will be to use recall rather than comprehension techniques.

6.6 Computer Logging System

The VLE has an inbuilt logging system which can be activated to track usage. This was activated in order to provide further evidence on the usage of the resource. This corresponds to an electronic observation of events, as indicated in Wragg (1994), Adler and Adler (1998), Bell (1999) and Cohen, Manion and Morrison (2000).

6.6.1 Information Available

The use could not be tracked across topics or across groups. It had to be accessed for each individual student, and then drilled down through each topic area and each individual lesson. This information gave the times of access, frequency, duration and subject matter for each individual in the form of tables. This data was collected at the end of each term for all individuals and collated across the year. This information helped to also produce evidence towards the meeting (or not) of the ILT strategy.

6.6.2 Linking with Research Questions

The research questions that the computer logging system linked with are listed in Table 6.9 below. These questions have already been asked within the questionnaires, and are providing an unbiased triangulation of events. Because the students are not aware of the logging system, the data it is generating is real, rather than providing what the students feel is required to show them in their best light.

How VLE resources are used	When	√
	By whom	√
	What	√
	How frequently	√
	Duration	√
	Ref ILT Strategy	√

Table 6.9: Logging Data by Research Questions

The students have to log on to the system using their own unique identifier and password, so it is their access only. They are not allowed to use each other's identifiers or passwords, as this contravenes the Colleges computer users' policy, and is a serious disciplinary offence which could lead to expulsion of the student. Consequently, this breach of use is not likely to have occurred. The only flaw would be that one student may have logged on and several of them are using the same screen/computer as a group together. Clearly the system can not be expected to reflect this.

6.6.3 Conclusions

Accessing the data is both cumbersome and time consuming. The system itself does not provide the required data in a suitable format. Although everything that is needed is available, the system is not set up for systematic detailed tracking. Although the data collected is accurate, the tools are not suitable for in depth research requirements.

6.7 Summary

This chapter described the development of the questionnaires through to the final version. The corresponding interview questions development was also discussed and amendments explained. It also gave a rationale to the interview questions to be used with managers with the inclusion of some of the questions. The results from the student questionnaires and interviews can be found as part of Chapters 7, 8, and 9 whilst the information from the management interviews provided much of the background to Chapter 4, as well as informing the conclusions arrived at in Chapter 10.

CHAPTER 7

ANALYSIS OF STUDENT PERCEPTIONS AND MEASURABLE OUTCOMES

7.1 Introduction

The data to be analysed to investigate the students' perceptions was gathered through the use of questionnaires and interviews. The questionnaires were completed once per term, giving three separate sets of data. The tables showing the spread of the data for each question are collated in Appendix D. The group interviews were conducted separately with students from each of the individual tutor groups, for both cohorts. Some of the students who attended the group interviews had not accessed the VLE resources. A number of students were also interviewed individually to look at the six areas of investigation, in more depth. These areas were detailed in Chapter 6, Table 6.1. The data obtained from the entry qualifications, computer logging and final results recorded. The entry qualifications data were based on application forms, certificates, and the completed initial information sheet given to the students at the start of the course. The computer logging records were automatically recorded by the Blackboard system and gave details of times, durations and dates of the students' access to each of the individual lessons. The final results came from the end of year results claims forms submitted to the examination awarding body by the college. The success rates and benchmarking figures have come from the official targets and reported rates based upon the LSC calculations and government projections.

7.2 Entry Qualifications

The entry qualifications were taken from both the students, and the verified recorded data about the students. By cross checking the entry qualifications in this way it was possible to be more certain about what qualifications the students actually had as opposed to what they remembered that they might have. A summary of the entry qualifications is shown in Table 7.1. The first column of each group is for the 04/05 data and the second column is the 05/06 data. Shaded columns indicate that the group was not running.

In both 04/05 and 05/06, the full time students were less qualified in all areas other than GCSE ICT, but the 05/06 intake had more formal qualifications than the 04/05 intake.

Entry Qualifications
On application for the National Level course, I had the following qualifications:

04/05 Total N = 119 **05/06 Total N = 125** **Qualification Types**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
BTec First Diploma	1	1	0	3	0	0		0	0	0	2	6		0	0	0	0		0	0	0	
Intermediate GNVQ	0	1	1	3	1	2		1	1	3	1	3		1	0	1	0		0	3	0	
Four (or more) GCSE grades A*-C	3	1	7	9	13	5		9	6	4	6	9		14	5	13	4		8	11	0	
Mathematics GCSE (A*-C)	1	2	1	14	5	7		9	2	3	3	12		15	2	10	2		5	9	0	
English GCSE (A*-C)	0	1	1	9	5	5		8	2	5	4	8		12	2	12	2		6	7	0	
ICT GCSE (A*-C)	0	0	0	2	1	3		3	0	0	0	0		3	1	2	0		5	3	0	
College Entrance Test	5	7	4	0	0	6		0	0	1	5	0		1	1	0	0		3	3	14	

Table 7.1: Student Actual Entry Qualifications

7.2.1 Prior Attainment Indicators

If the student entry qualifications are taken as an indicator as to their future attainment, then, in theory, if they have the required entry qualifications they should be able to pass the course. As having Mathematics GCSE A* to C, or a proven ability within the subject area as demonstrated through the First Diploma, Intermediate GNVQ or the College Entrance Test, is part of the entry requirements; there should be no reason why any student meeting these requirements cannot pass the mathematics unit. English and ICT GCSEs were also considered in the collection of qualifications as they are useful indicators as to how ICT literate students are, and to how easily they would be able to use the VLE mathematics resource.

Looking at the results simplistically, students need a First Diploma or an Intermediate GNVQ or the College Entrance Test or four or more GCSEs A* to C, including Mathematics in order to start the courses. Some students have more than one of the qualifying requirements whilst others have none of them. In 04/05 overall just over half of the students (59%) met the requirements (of which 78% were part time) and in 05/06 overall nearly all of the students (91%) met the requirements (of which 78% were part time).

The final results for 04/05 show a very high level of success compared to the initial potential predictions. The predicted value of 55% overall has realised 72%, the predicted value of 47% for the part time students has realised 77%, and the predicted value of 12% for the full time students has realised 63%. In terms of value added this is outstanding.

The final results for 05/06 show some increase in success compared to the initial potential predictions. The predicted value of 95% overall has realised 70%, the predicted value of 71% for the part time students has realised 77%, and the predicted value of 20% for the full time students has realised 50%. In terms of value added this is mixed – the overall result is satisfactory, the part time is good, and the full time is outstanding.

7.3 Computer Logging

The tracking facility of the VLE was enabled in order to provide information about what was viewed, when and by whom. None of the students' accessed individual lectures from a topic area, even though they were available in that way, they always looked at all of the lectures within that topic area – so they did not just look at lesson five, for instance, but looked at all of the algebra lectures.

7.3.1 Access by Groups

In the 04/05 study all groups, except the Fabricators, accessed the topic areas. This can be seen in Figure 7.1.

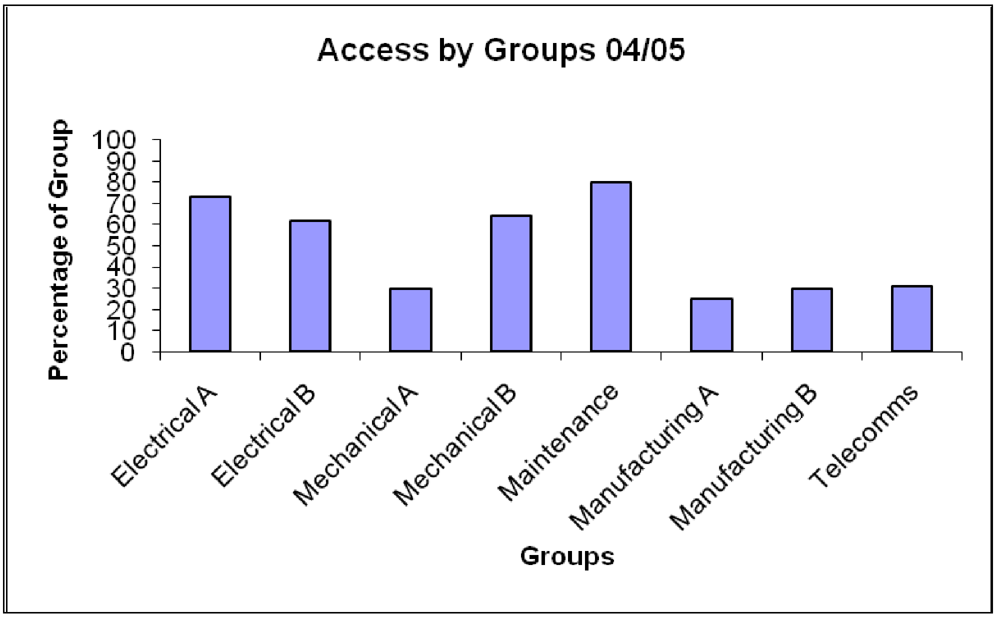

Figure 7.1: 04/05 Individual Group Access to the VLE Resources

The Mechanical Groups were of different ages. Group A were of a similar age to the full time students, and their percentage access is very similar to the full time groups' access. Group B were mature students, and these older part time students made greater use of the resources. The Electrical groups ran out of time to complete the syllabus so were directed to use the resources to pick up all the information that they needed for the topic area “Statistics”, but this group also had several members who were keen to have resources accessible from outside of the College. If the groups are combined into their engineering specialisms, the access rates can be seen more clearly, as shown in Figure 7.2.

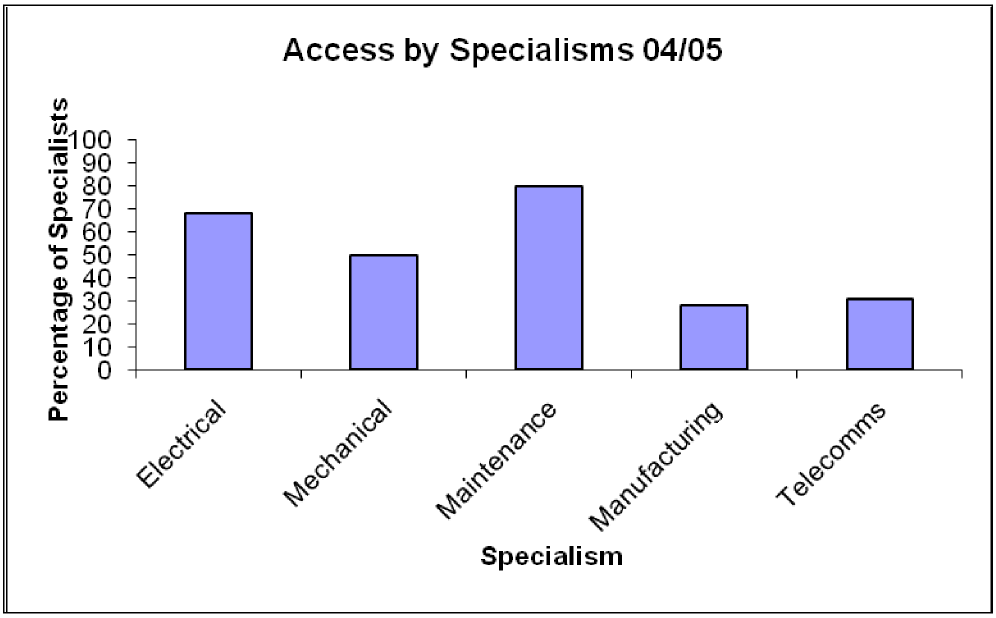

Figure 7.2: 04/05 Specialist Group Access to the VLE Resources

The Maintenance group accessed the resources more than any other group, with 80% of them using the resources. This was despite the fact that they only attended the College for the first and last terms, of which the last term was the only time they could access the VLE resources. However, their use can be explained by the group being very small and the fact that they all stayed in hotels or bed and breakfast establishments many miles away from family and friends, and all had easy access to the internet at their boarding places.

If the access of all the students is considered, exactly 50% of the students accessed the resources. The frequency distribution, in Figure 7.3, shows that the access is not limited to just viewing once. Many of the students accessed the materials on several occasions. The extreme values were 18 and 28 times, both by part time, older students.

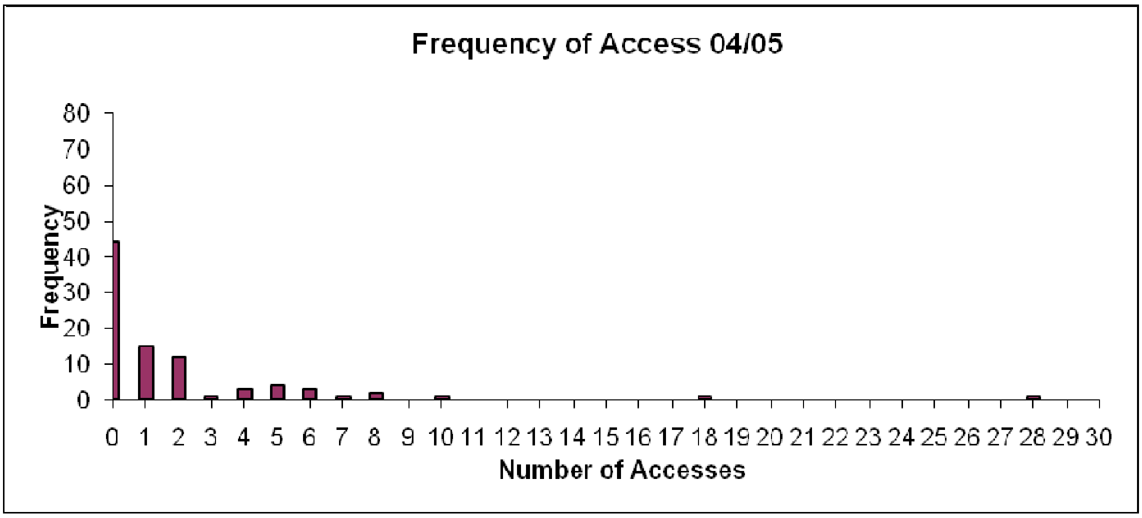

Figure 7.3: 04/05 Frequency of Individual Student Access to the VLE Resources

However, Figure 7.3 does show that the modal access value is zero. Using the resources is an option, and not obligatory. The reasons for not using the resources have been identified as “unnecessary” as the subject is straightforward, forgetting that the resources were available, lack of access to the internet outside college and laziness.

In 05/06 most groups, except Mechanical Groups A and C, accessed some of the topic areas. These groups had no lecturers using the VLE on a regular basis due to limited access through room timetabling issues. This also included second year students who had finished with the material in the previous year. The access can be seen in Figure 7.4. The Mechanical Group B were of a similar age to the full time students in that they had very recently left school, but their percentage access is very different to the full time groups’ access. The older part time block release Maintenance students made the greatest use of the resources. The Electrical groups all accessed the resources, despite only being day release students and having more limited opportunities to access the resources whilst in college. The Electrical Group A used the resources the most out of the Electrical groups.

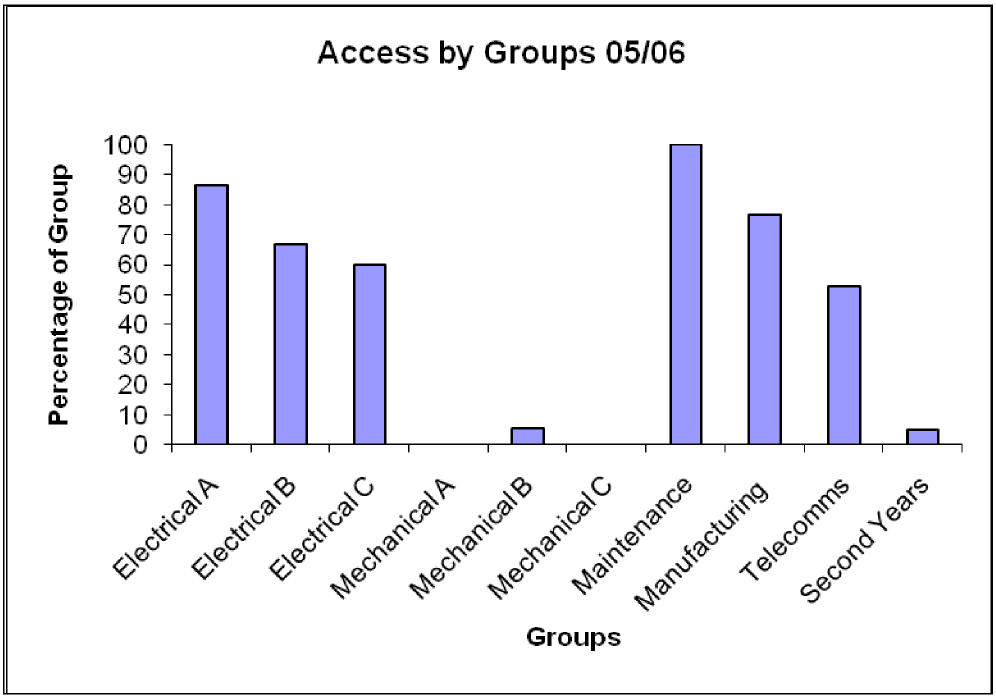

Figure 7.4: 05/06 Individual Group Access to the VLE Resources

If the groups are combined into their engineering specialisms, the access can be seen more clearly in Figure 7.5.

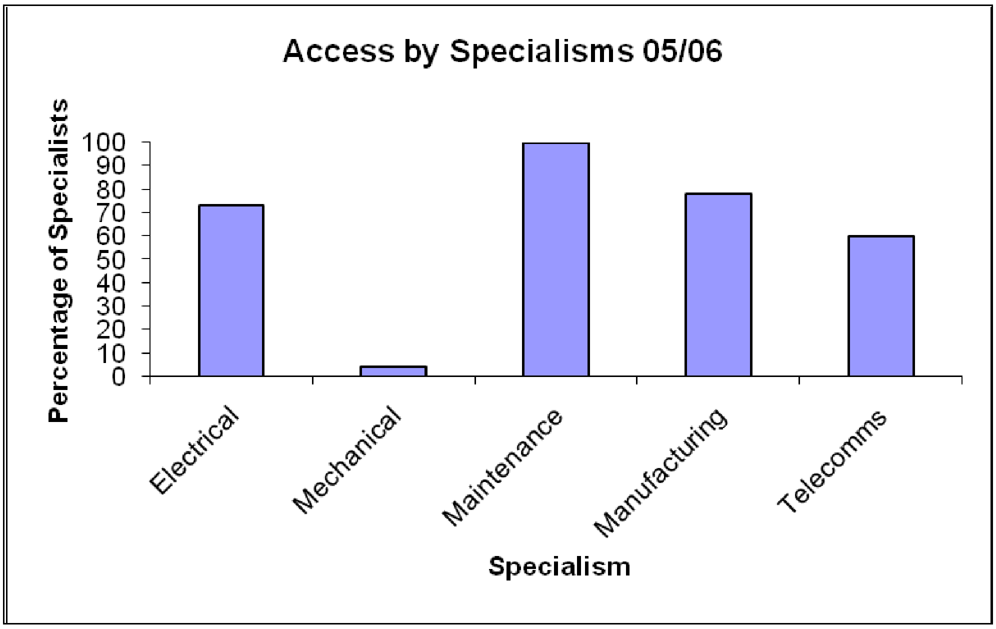

Figure 7.5: 05/06 Specialist Group Access to the VLE Resources

The Maintenance group accessed the resources more than any other group, again. It should be noted that the Mechanical groups are the only groups whose course lecturers do not put the work for the majority of their course units onto the VLE at this time, and they are not generally encouraged to use the VLE by their engineering lecturers. Consequently they made the least use of the mathematics resources. They are part time students too, and would have had limited opportunity whilst in College to access the resources due to being timetabled into rooms that did not provide internet access. They rarely had access to computers, other than for specialist units such as AutoCAD.

The Electrical groups made good use of the resources. Although they too were part time students, they were frequently timetabled into rooms with computer access and frequently used the computers with the majority of their units. The Manufacturing and Telecommunications students were all full time so they had a much greater opportunity to access the resources at the college, and most students used them.

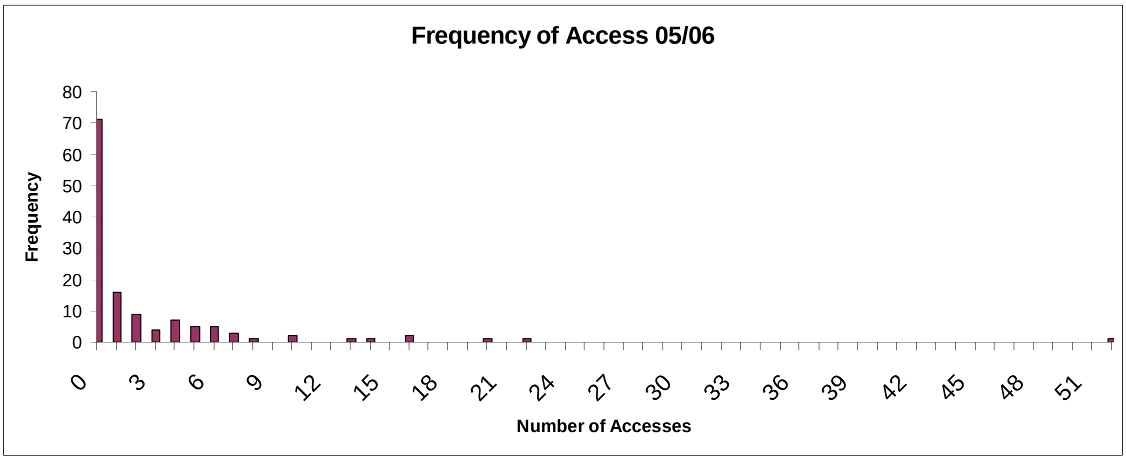

Figure 7.6: 05/06 Frequency of Individual Student Access to the VLE Resources

If the access of all the students is considered, exactly 45% of the students accessed the resources. The frequency distribution, in Figure 7.6, shows that the access is not limited to just viewing once. Many of the students accessed the materials on several occasions. The extreme value was 52 times, by a full time, older student. However, this does show that the modal access value is still zero. The reasons for not using the resources have been identified as being similar to those that were given for 04/05.

7.3.2 Access by Topic Areas

In 04/05 all of the topic areas had been accessed. The comparative access can be seen in Figure 7.7. Neither "Graphs" nor "Applied Problems" were accessed by the Telecommunications group. Both of these topics were assessed by assignments, so there was no test or exam set, with "Applied Problems" relating specifically to the higher grade work. The other area assessed by assignment is "Statistics". The Electrical group have looked at this the most, which reflects the fact that they had to find out about this topic area for themselves due to a lack of teaching time. The Mechanical group looked at "Algebra" more than the other groups. This had been covered in the first test, and many of the group needed to pick up partial criteria through retests to gain the overall pass for this topic area. "Shape and Trigonometry" was covered in the second test and this topic area was looked at most by the Telecommunications group, many of whom did not have the entry level qualifications and so had no background knowledge to build on for these topics.

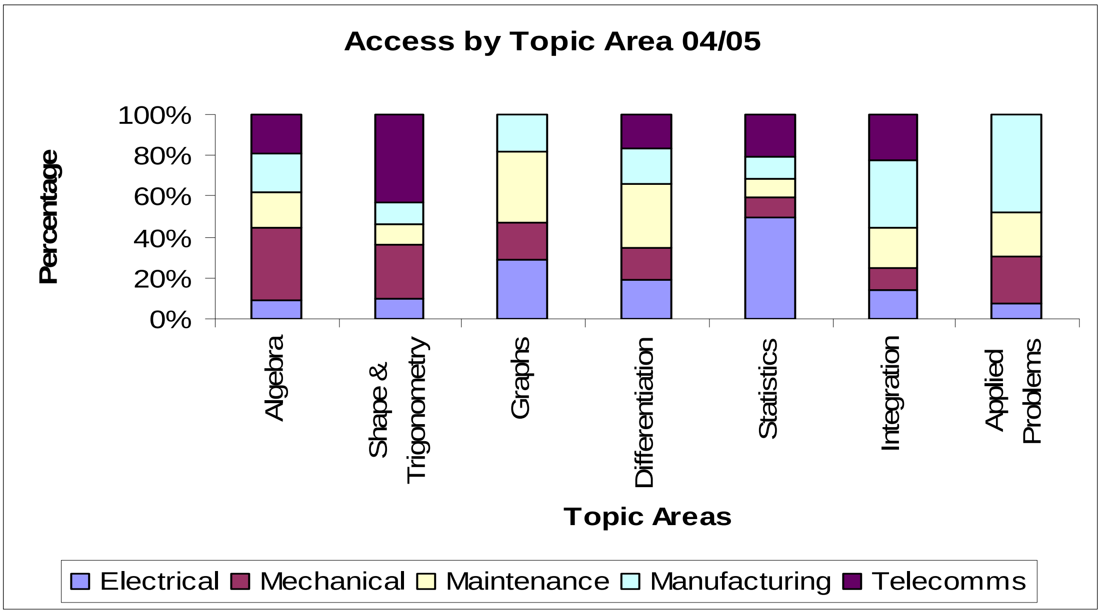

Figure 7.7: 04/05 Comparison of Group Access to Topic Areas

If the access by the Part time students is compared to the Full time students, a different picture emerges, as is shown in Figure 7.8. The access to "Algebra" was the same for both groups, but "Graphs", "Differentiation" and "Statistics" were looked at mostly by part time students. Graphs and statistics were both assignments, and they were directed towards the statistics for self study. The full time groups would have had to complete extra work on both of these topic areas as part of their Key Skills study, so would already have looked at them in a different way in other classes. The differentiation topic was assessed by an examination, so the part time students would have studied this more to make sure that they were able to pass first time. The full time students did not see passing first time as being vital, as long as they passed it at some stage.

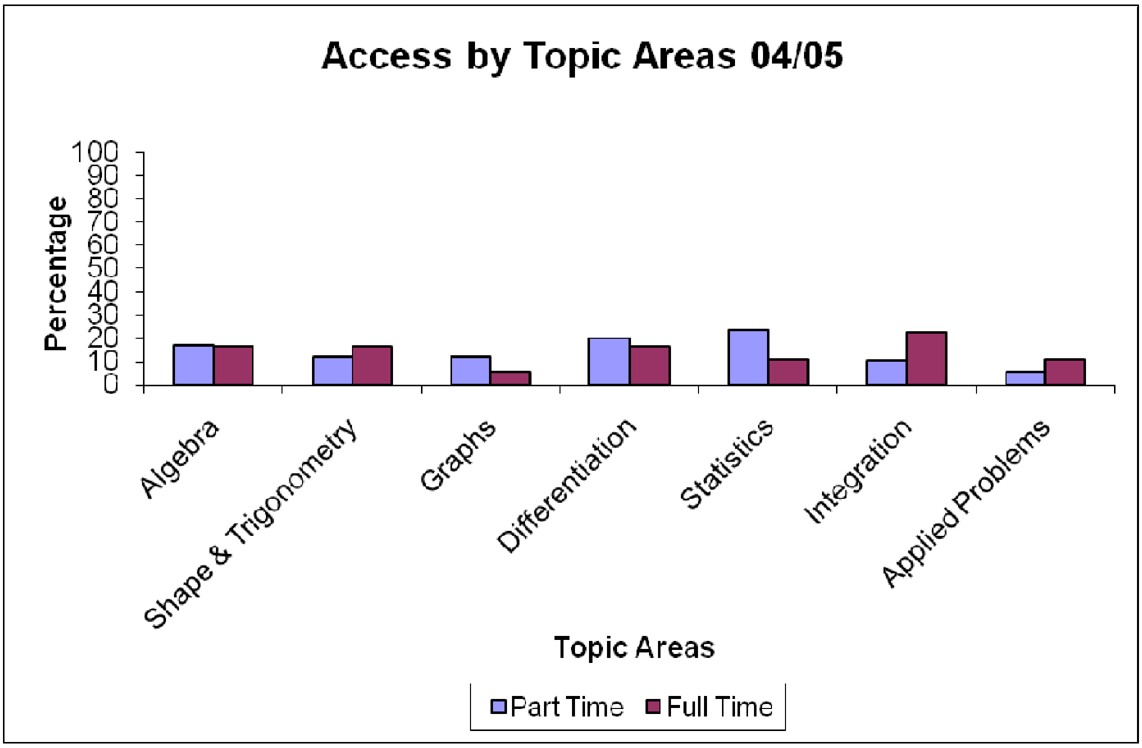

Figure 7.8: 04/05 Comparison of Access to Topic Areas by Attendance Style

The more complicated areas of the "Integration" and "Applied Problems" topics were looked at least by the part time students. This was because most of this related to the higher grades of merit and distinction. Many of the part time students had already chosen to go for pass grades only, as that was the minimum that they needed to progress. They preferred to spend their time studying what they regarded as more important units – such as their main engineering qualification units. The full time students consisted of several who wished to progress to university at the end of the two year course. They needed the higher grades in mathematics in order to have a wider choice for progression. As the Mechanical group only study half of the Mathematics unit in year one, they would not have needed to look at these areas yet.

Looking at Figure 7.9 the most popular topic overall was “Statistics”, probably because this was the topic area that had to be self studied by several groups. The least popular topic was “Applied Problems”, probably because this covered higher grade work and not all students wanted to attempt this. “Differentiation” and “Algebra” stood out as areas that the majority of students looked at. As both of these are areas that students have difficulty with, this was not a surprising result.

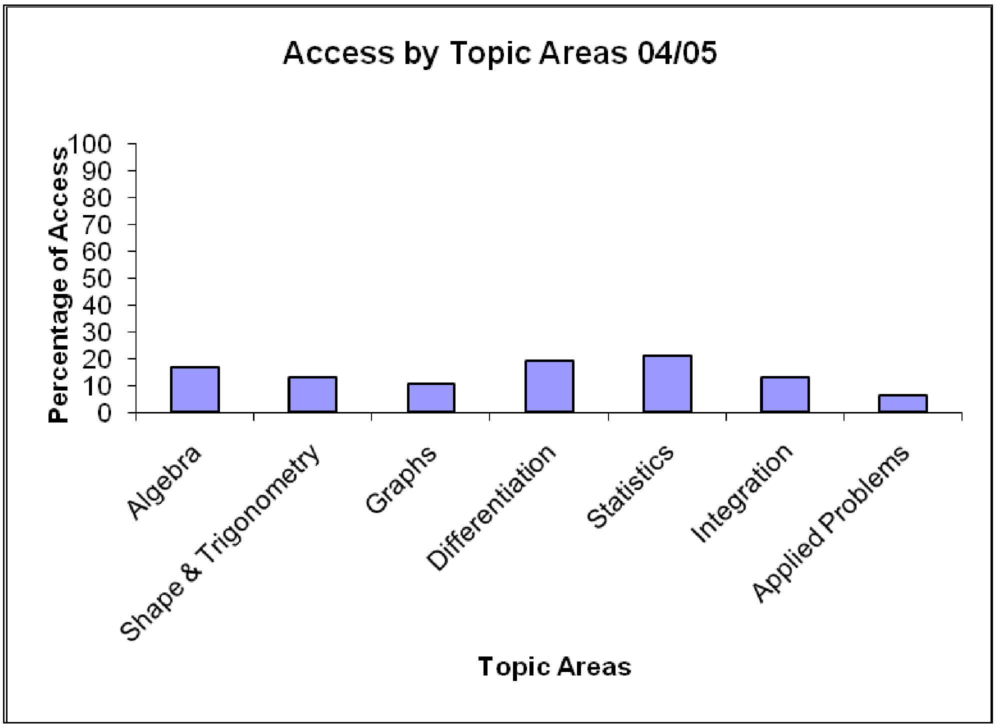

Figure 7.9: 04/05 Comparison of Access to Topic Areas

In 05/06 all of the topic areas were accessed again. The comparative access can be seen in Figure 7.10. “Shape and Trigonometry” was not accessed by the Mechanical groups. This is a topic that they would have come across in their Mechanical Principles unit as well as mathematics, so they should have been very familiar with this and did not need any extra support. “Algebra” was accessed most by Electrical and Maintenance groups, who both lacked confidence at the beginning of the course; whilst the Manufacturing group accessed both “Shape and Trigonometry” and “Statistics” most, areas that they should have known well from their school studies, but were very unsure about. Telecommunications accessed “Shape and Trigonometry” excessively, indicating that not only did they all look at it, but that they also looked at it several times. This corresponds with the need to pass the examination in this topic area, as in the previous year. The Mechanical group looked at all topic areas that they accessed equally. The least accessed topic varied between the groups.

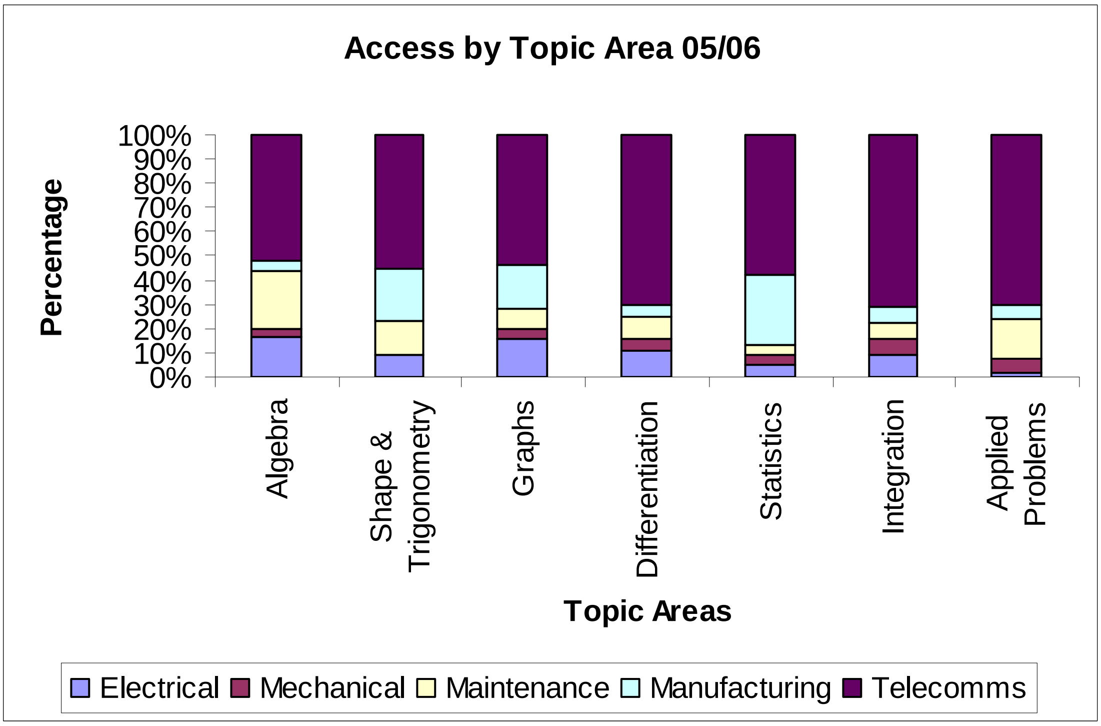

Figure 7.10: 05/06 Comparison of Group Access to Topic Areas

Telecommunications access for all topics was very high, reflecting the lack of entry qualifications that this group had, and their weaknesses with mathematics.

If the access by Part time students is compared to Full time students, a different picture emerges in comparison to the previous cohort, as is shown in Figure

7.11. The percentages shown on the graph in Figure 7.11 represent the total number of part time students and the total number of full time students as separate values. There is no access that was the same for both groups.

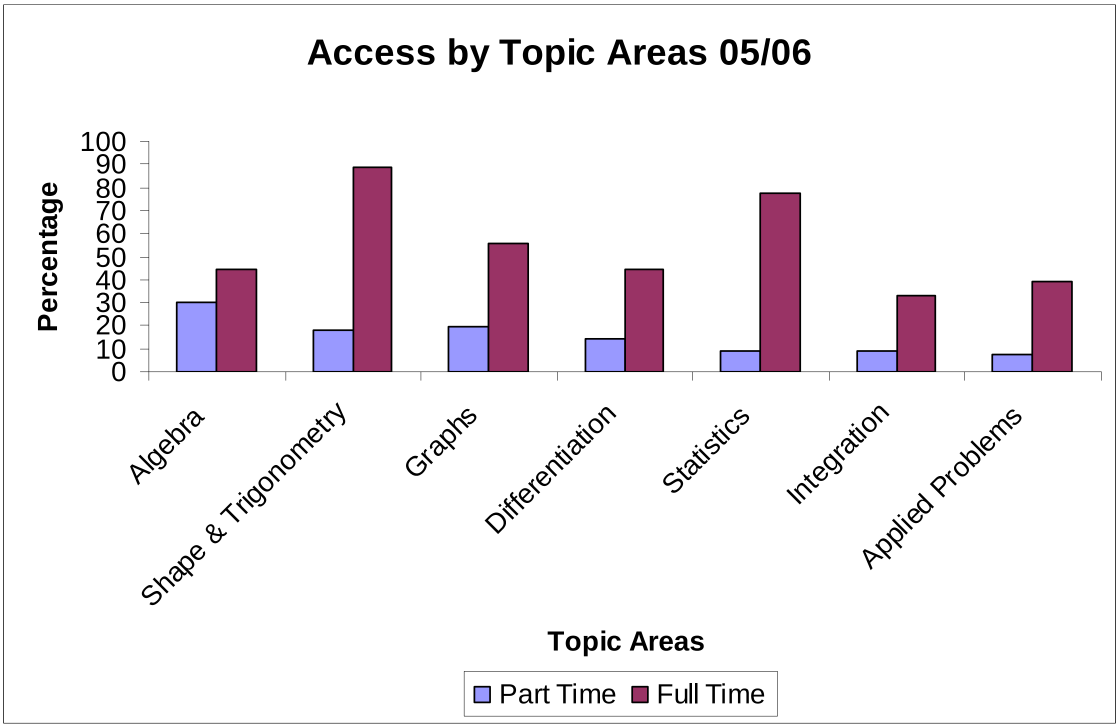

Figure 7.11: 05/06 Comparison of Access to Topic Areas by Attendance Style

"Algebra", "Graphs" and "Shape and Trigonometry" were the favourite choices for the Part time students, whilst the Full Time students looked mostly at "Shape and Trigonometry" and "Statistics" and "Graphs". The access by the part time students was much lower than in the previous year, whilst more of the full time students accessed the topics. As the part time students were more appropriately qualified in 05/06, they had needed less support with the mathematics than the previous cohort. The full time students were less appropriately qualified than in the previous year, in that less of them had a mathematics qualification of an appropriate level. This meant that the full time students from the second cohort needed greater support. Also, the full time groups were larger than the part time groups, which meant that there was less opportunity for individual support in class.

Figure 7.12 shows that the most popular topics were “Algebra” and “Shape and Trigonometry”. Both of these were covered in the early part of the course and both were tested under examination conditions. This meant that the students felt that they needed to know the material well in order to pass.

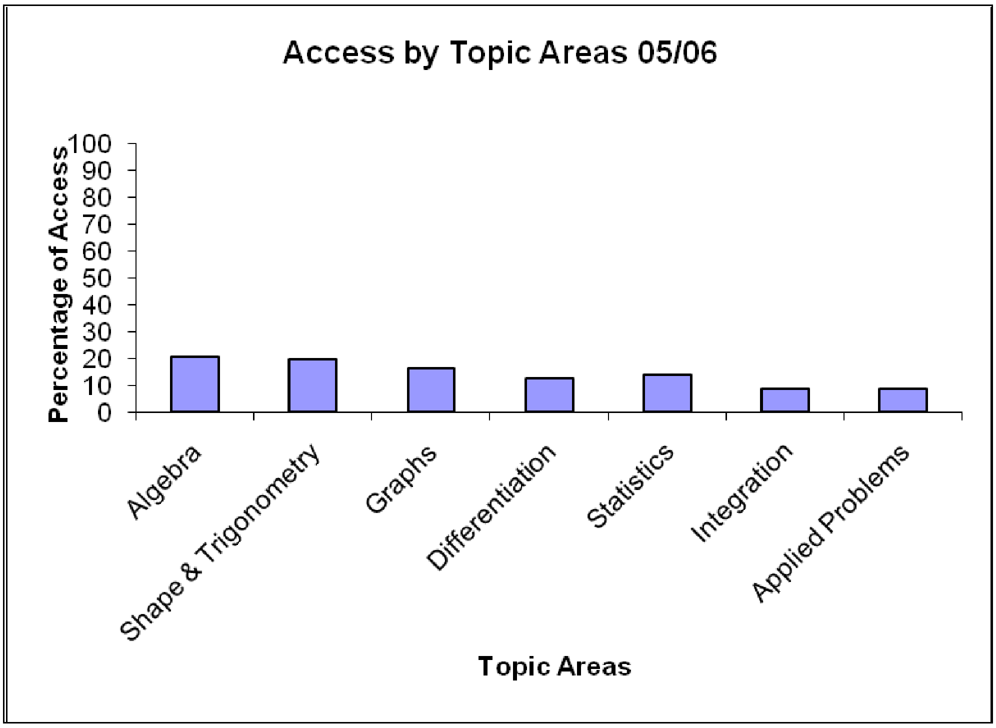

Figure 7.12: 05/06 Comparison of Access to Topic Areas

The least popular topics were “Applied Problems” and “Integration”, both of which contributed to the higher grades of merit and distinction. Fewer students chose to try for these grades, and this was reflected in the lesser access. “Graphs”, “Differentiation” and “Statistics” were not as popular with the majority of students, as they felt that they were more familiar with these topics, or that the content just seemed easy to remember. The graphs and statistics were assignments, so there was a greater opportunity to talk things over before handing work in.

7.3.3 Month of Access

In 04/05 the resources were posted onto the VLE during the first term, so were not all fully available until January. Once they were available, all of the groups were shown how to access the materials. Some students accessed them immediately, but others did not access them until much later. Some of this was due to a problem with logins, which took a long time to sort out.

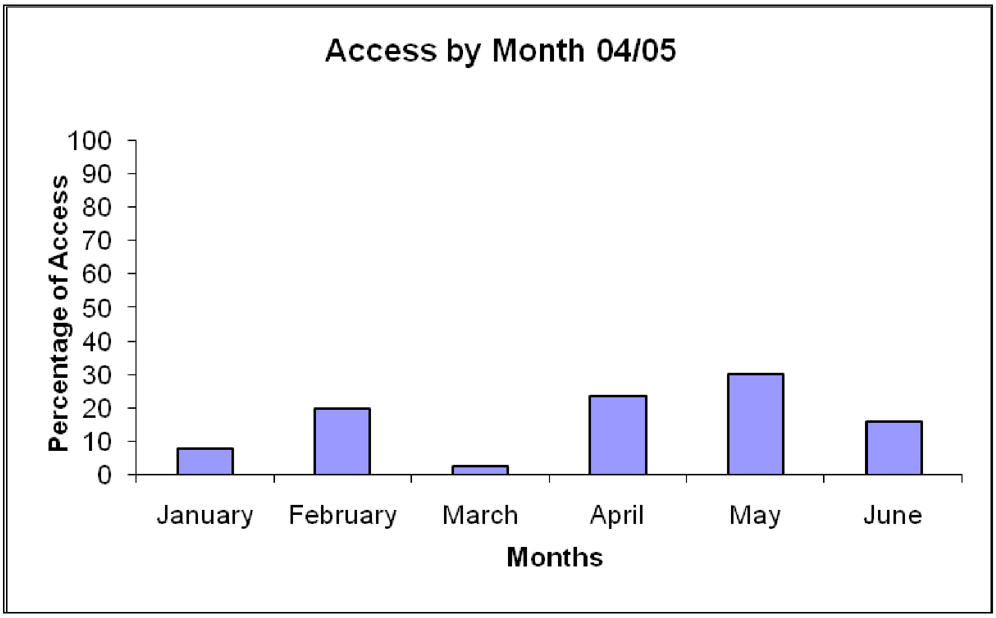

Figure 7.13: 04/05 Comparison of Month of Access

The activity is greater in April and May, which coincides with the "Statistics" work and the beginning of revision work for retests on partial criteria at pass level. It was also at this point that all of the logins were finally activated. The distribution can be seen in Figure 7.13. The least access was during March, which corresponded to the Easter vacation.

In 05/06, the resources were already posted onto the Blackboard site when the students started in September. As the College was in the process of switching over to Moodle completely by 06/07, the resources were also posted on the Moodle site as well, in the same format. The statistics here are considered as if the two platforms were the same site, rather than two separate ones.

Having the resources available in September meant that there was a high access during this first month of the course. The next peak was in February and March. These corresponded to tests and assignment dates.

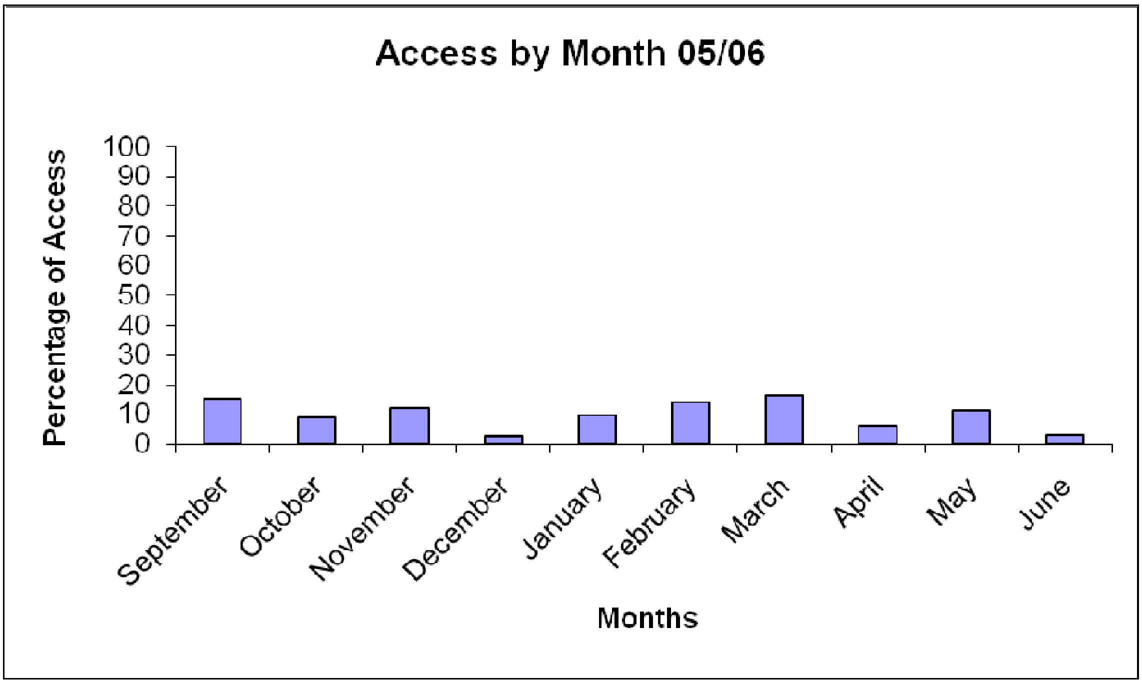

Figure 7.14: 05/06 Comparison of Month of Access

The least favourite months for access were December and June. The holiday periods were in December, April and June, which was when there were the lower access rates. The distribution can be seen in Figure 7.14.

7.3.4 Days of Access

In 04/05 the majority of Part time students attended on Wednesdays (4 out of 5 groups), with the other Part time group attending on Thursday. The distribution of access from the dates seemed to reflect this, with Wednesday having 43% of the access, as is shown in Figure 7.15. Mondays and Fridays were the least popular weekdays. Students clearly accessed the materials in their own time as well, as both Saturday and Sunday came up as days for access.

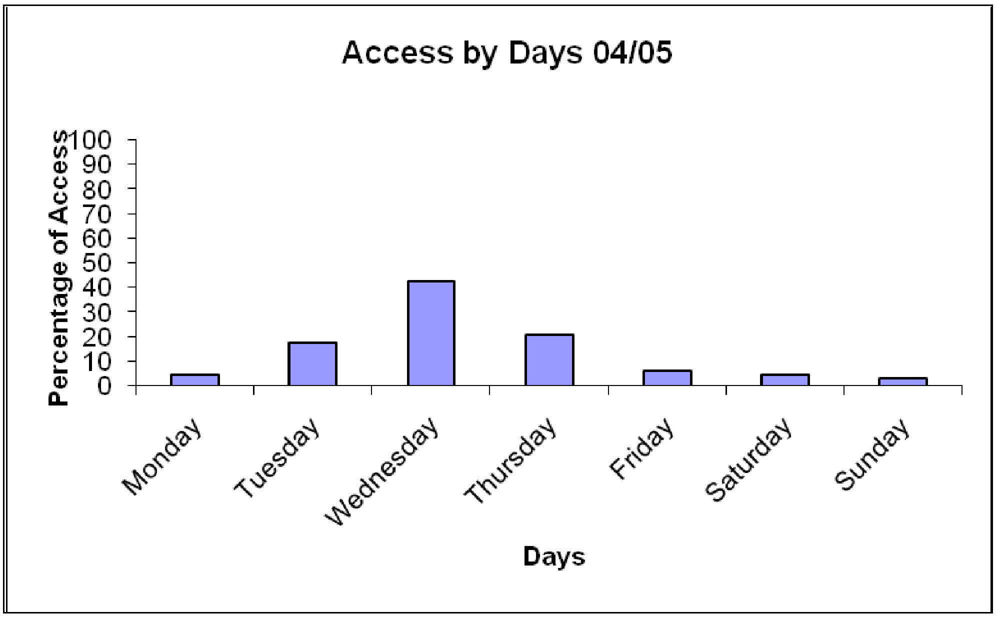

Figure 7.15: 04/05 Comparison of Days of Access

In 05/06 the Electrical Part time students' attendance was split between Monday, Tuesday and Thursday due to rooming changes. The Mechanical group's attendance remained on Wednesdays. The distribution of access from the dates seemed to reflect this new split, as is shown in Figure 7.16. Friday was the least popular weekday. This was because for the part time students it was a half day at their employers and was traditionally used as a social or family event. The full time students started College later in the day (after 10.00 a.m.) due to staff meetings, but there was no library access during the meeting time. This meant that the students had no access to the VLE resources as none of the College computers were available from the library or classrooms. Due to the late start, the rest of their day was very tightly scheduled, with very little time to access the resources, other than when specifically directed to do so during classes. They too used the Friday as a social evening rather than a study night. Students still accessed the materials in their own time as well, as both Saturday and Sunday were registered as days for access at similar levels to the previous cohort.

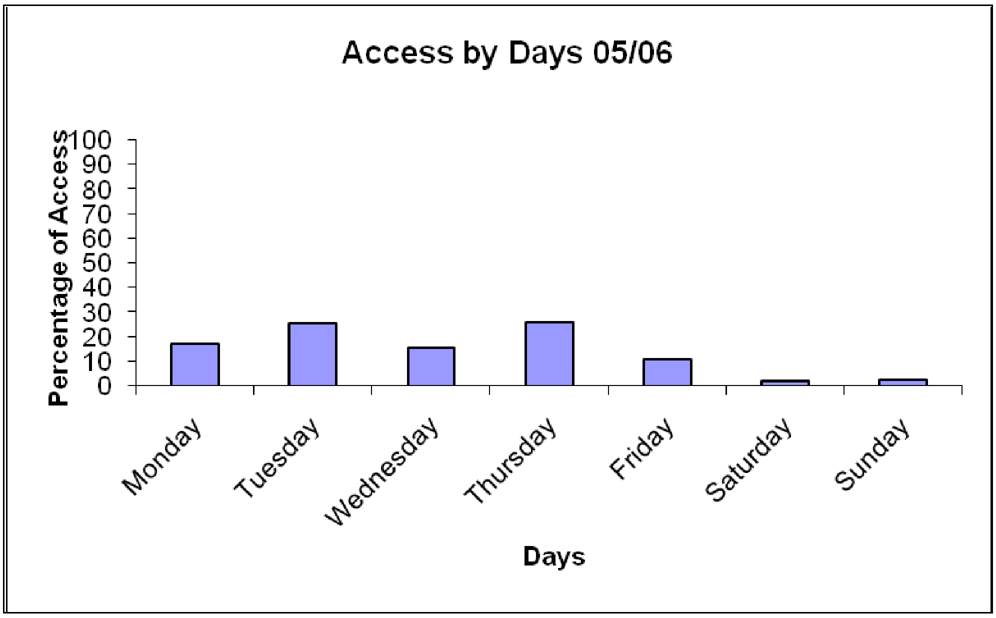

Figure 7.16: 05/06 Comparison of Days of Access

7.3.5 Times of Access

In 04/05 most of the access was in the afternoon and early evening. There were only a couple of students that worked in the very late evening and at midnight, as is clearly illustrated in Figure 7.17. The peak time was 18.00 hours (28%), with 19.00 hours (12%) and 10.00 and 15.00 hours (10%) being the next most popular times. The full time students' College day finished at 5.00 p.m., so that they would be arriving home from 5.30 p.m. onwards. This corresponds to both the 18.00 hours and 19.00 hours access.

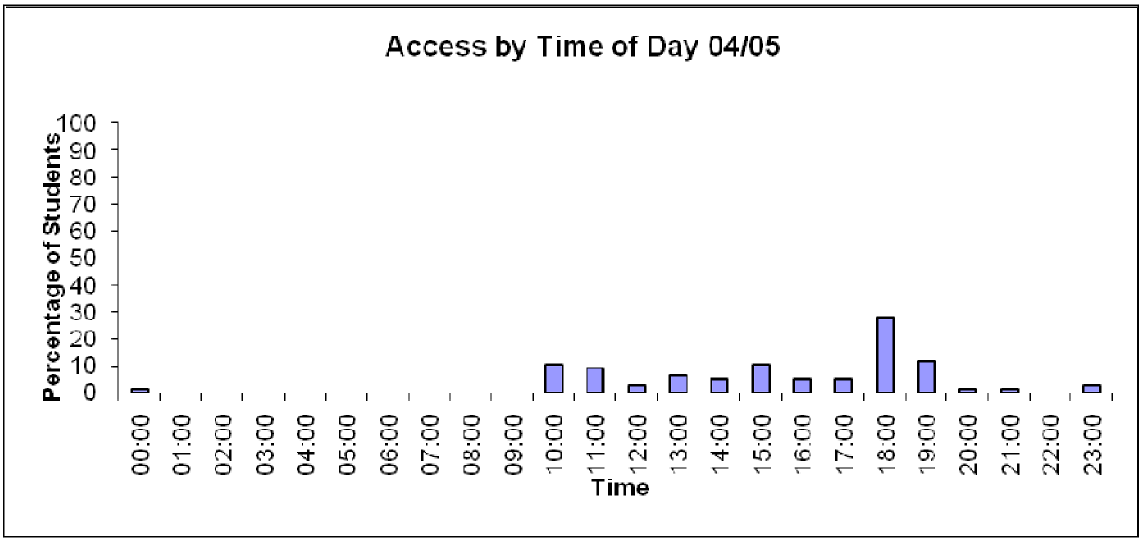

Figure 7.17: 04/05 Comparison of Access by Time of Day

The part time students had a break between the day and evening sessions. This was at 6.00 p.m., and many of them used the time to go to the library and access the materials. The 10.00 a.m. and 3.00 p.m. time slots corresponded to the full time students Tutorial and Key Skills lessons, which were in a computer room, so they would have used this opportunity to access any notes to help them with their work or to catch up on anything that they needed help with.

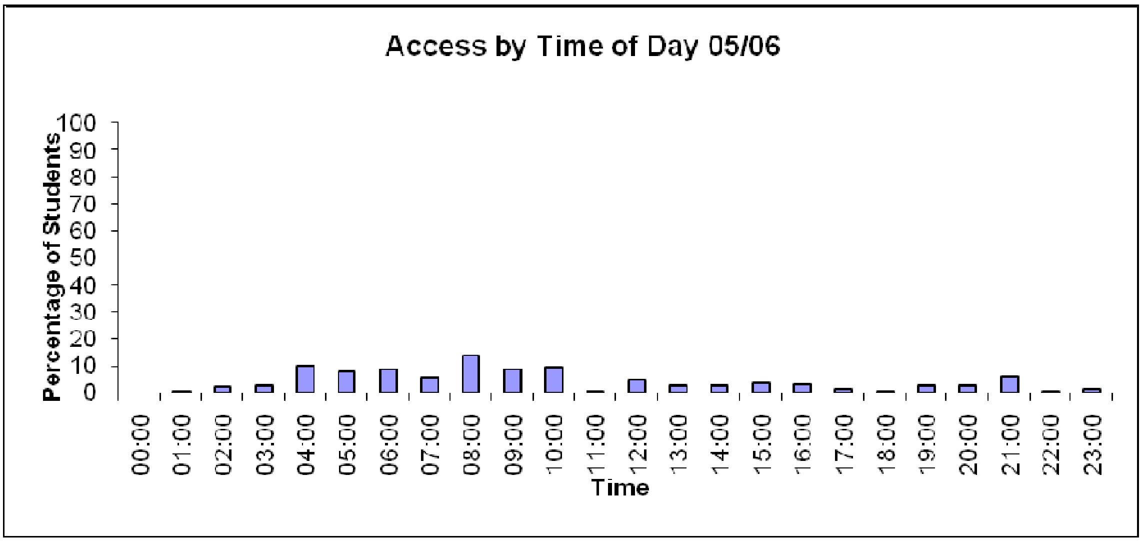

Figure 7.18: 05/06 Comparison of Access by Time of Day

In 05/06 most of the access was in the very early and mid morning with some in mid afternoon and early evening. There were several students who worked in the very late evening and through the night. This is clearly demonstrated in Figure 7.18. The peak time was 08.00 hours, with 04.00 hours and 06.00 and 10.00 hours being the next most popular times. There was minimal access at the previous years' maximum access time of 18.00 hours, and there is only midnight which does not record any access. There was a larger number of part time students in this cohort, and they accessed the materials before coming in to college, rather than whilst they were at college. Those who lived closer to the College accessed at 8.00 a.m., whilst those who lived further away tended to access the materials at 6.00 a.m. This group preferred to go off site between the day and evening rather than work in the library. This was why the 18.00

hours access was minimal. The 10.00 a.m. slot corresponded to a Tutorial slot for the full time students, again. The 4.00 a.m. slot was a strange time. This was when many of the full time students accessed the materials, although some of the part time students who were working night shifts also used this time whilst at work. The strange time may have been due to last minute working on the part of the full time students. They may have stayed up all night on different occasions to complete due work before their next session.

7.4 Student Reporting

The student questionnaires and interviews also provided information about what was viewed, when and by whom. They also provided a greater depth of perception and opinion than could be gathered from the purely factual data of the logging system.

7.4.1 How VLE Resources are Used

The VLE was demonstrated by course tutors at the start of each academic year and its use for materials and information was emphasised. This was despite the mathematics resources not being available at the start of the 2004/05 year. There was no insistence that the mathematics resources had to be accessed or used. By the second and third terms, however, the results show that many students had forgotten all about the mathematics resources. The Mechanical and Fabrication groups only had a limited number of subject resources on the VLE, but their awareness of the mathematics resources was similar to that of other groups who used the VLE more frequently in their other subject classes. This can be seen in Table D.1, which summarises the response to the question about student awareness of the Blackboard resources.

There was a difference in resource usage between 04/05 and 05/06. In 04/05 there are two groups of students, the Fabrication and the Telecommunications groups, who claimed that they did not access the mathematics resource at all. However, all of the groups accessed the mathematics resources during 05/06, although the numbers within the Mechanical groups were more limited. Table D.2 gives details of the level of usage, as well as the reasons for using or not using the resources. The reasons for accessing the resources were very focused – extra support, previewing and revision. The number who claimed not to know about the resources dropped over the year. Accessibility to the VLE improved over the year and fewer students felt that they needed to avoid computers by the end of the year. There was a set of students who “could not be bothered”. This was fairly constant throughout both terms in 05/06 at approximately 12%, but reduced from 17% to 4% in 04/05. In 04/05, of those who didn’t use the resource, the main reason cited was because they *“didn’t need any extra help”*. One student admitted that he had meant to look at the resources, but he *“didn’t get round to it”*. In 05/06 the students who did not use the resources stated that they did not need to because they were good at the subject anyway.

All of the students agreed that they would use the internet to help them with mathematics topics, although one of the Manufacturing students found that *“It is easier to use for other subjects, I find I get confused with the maths information so I prefer not to use it”*. The Telecommunications students regularly made use of the internet as an extra source of information and one of them stated that *“If there isn’t enough help on Moodle I go onto Google”.*

The results from the rating table for the frequency of using or looking at the mathematics resources can be seen in Table D.3. There was an increase in use of the resources from term 2 to term 3 as well as an increase between 04/05 and 05/06. The numbers using the resources remained fairly constant but the frequency of this use increased substantially. In 04/05 the frequency of use of the VLE resources was quite limited. Most of the students either said that they hadn't accessed it at all, or that they had only accessed it a couple of times. In 05/06 the frequency of access varied, according to how the students were using the resources. Some of them never used them at all; some only looked at them when others were doing so, some at the beginning of the course, and others throughout the course.

The average time spent looking at the resources also increased from term 2 to term 3 and from 04/05 to 05/06. These figures are summarised in Table D.4. The usage pattern shows that the most frequent periods of time are between 5 to 30 minutes or more than an hour. The first time period indicates that students are looking for information, finding it and then reading through it in some detail. The second time period indicates that not only are they finding and reading through the materials, but that they are engaging with them as well. This shows that the resources are not just being browsed through, but are actually being studied.

Table D.5, summarises what the students were looking at in terms of the overall resource and its format. It was useful to know whether the students were dipping in to the resource or following it line by line. In term 1 the students indicated what their likely use of the resources might be. The actual figures for those accessing the resources in terms 2 and 3 were lower than the initial responses indicated. In 04/05 there was an increase in use between terms 2 and 3, but for 05/06 the figures remained fairly constant. The most popular use of the resources was to look at parts of individual lessons, whilst the least popular choice was to look at the background information and the basic mathematics needed for the course. The materials on the VLE were also used differently by the students. Their comments were not restricted to just the use of the mathematics materials on the VLE; they also described what they do in general terms. The part time students used the materials more interactively than the full time students, who often just downloaded notes without trying any of the exercises. The part time students' use was more varied than that of the full time students; as can be seen from the statement below made by a part time student.

> *"I've used them [resources on Blackboard/Moodle] mainly for revision, for practising and doing the online tests".*

The Telecommunications students were the more pro-active of the full time students in their use of the resources in that they would search through the materials. One of the students also made copies of the resources to have them permanently available for his own use, as stated below.

> *"I usually save it to my area or pen drive so that I can take it home to do extra work".*

The Manufacturing students' use was very limited. The main reason given for using the mathematics resources was to *"catch up notes for other subjects".* All of the students used the resources to follow up or recap the previous lesson, prior to the next. In terms of accessing the mathematics resources, the reasons that were given by both the full time and part time students related to having a good working knowledge to build upon for the next lesson. They clearly wanted to feel comfortable with both the mathematics content and their teaching group. This was stated quite openly in a part time student's interview.

> *"I know that the lessons always start with a recap, but one week I hadn't done this, and I found myself lost from the start because I had forgotten the work from the previous week. After that I always looked at my notes and Moodle and I found that it cemented in and it gave me a better base to work from and I didn't feel left behind".*

One of the Telecommunications students looked at the resources before the lesson as well as after the lesson for mathematics. Once again, the reasons were to have a good base to work from and to feel comfortable with the mathematics, as the following statement shows.

> *"Afterwards I could go over it and it would stick a bit better and before it would help me to revise the lesson so that it would be easier to follow in class".*

Table D.6 shows the figures for the reasons behind accessing the resources. The term 1 figures are projections of what the students felt they might use the resource for, whereas terms 2 and 3 are what they actually used the resource for. Once again, the predicted use figures are higher than the actual use figures. In 04/05 the use increases from term 2 to term 3, but in 05/06 the use decreases from term 2 to term 3. Where students had indicated more than one response, they were asked to state their main reason. The main reasons given for accessing the resources were to remind, revise and to help understand. Revision was a greater factor in 05/06 than in 04/05, when there were more part time than full time groups. In 04/05 several students had used it specifically for assignment work whilst others used it mainly for revision purposes. Some students used it more regularly and they tended to use it to improve and organise their notes. A couple of students used it to catch up on work they had missed or did not understand. In 05/06 the reasoning for using the resources (or not) was very similar to the previous years cohort.

The students reported a mixture of reasons as to why they used the VLE resources. The part time students frequently used them to help overcome difficulties with mathematics, along with other approaches; whilst the full time students used other methods to overcome difficulties, such as talking to friends and the lecturer, and going through questions. Most of the students have begun to use Moodle more than Blackboard by 05/06, as this has become the recommended VLE platform during the final year of the study. This can be seen from the statement below.

> *"I would go back to the Moodle site [to overcome difficulties with my mathematics] and look back over the maths notes".*

The full time students clearly made use of the fact that their lecturer and friends were readily available. One of the Manufacturing students expected to have a lot of repeated input from the lecturer to help her, as follows.

> *"With difficulties … I would get them to go over it several times".*

However, the Telecommunications students seemed to be more self reliant, and were more likely to ask whoever is at hand to get some help, and will then work from there. This can be seen in the following statement.

> *"I prefer to ask the lecturer because they can explain it properly, but if my friends were there then they can usually explain some of it".*

Both the Electrical/Electronic and Telecommunications students regarded Moodle as their initial source of information if they needed to catch up any lessons. This can be seen by the following statement from a Telecommunications student.

> *"I look it up on Moodle to see if there is anything there first. I don't want to fall behind and fail the course".*

This is echoed by an Electrical/Electronic student who stated

> *"If I missed a lesson I would catch up by either getting notes off Moodle or getting notes off friends".*

The students in both of these disciplines had extensive notes available from all of their lecturers on Moodle, whereas the Manufacturing students did not. The Manufacturing students seemed to prefer to get notes from friends, as seen below.

> *"I get the notes from a friend or photocopy them and get the teacher to go back over it".*

The lesson topics students claimed to have accessed are summarised in Tables D.7 and D.8. Of the respondents who answered, there was greater use made of the resource in 05/06 than in 04/05 through volume of numbers. This can be seen visually in the graph summaries for terms 2 and 3 as shown in Figures 7.19 and 7.20 respectively.

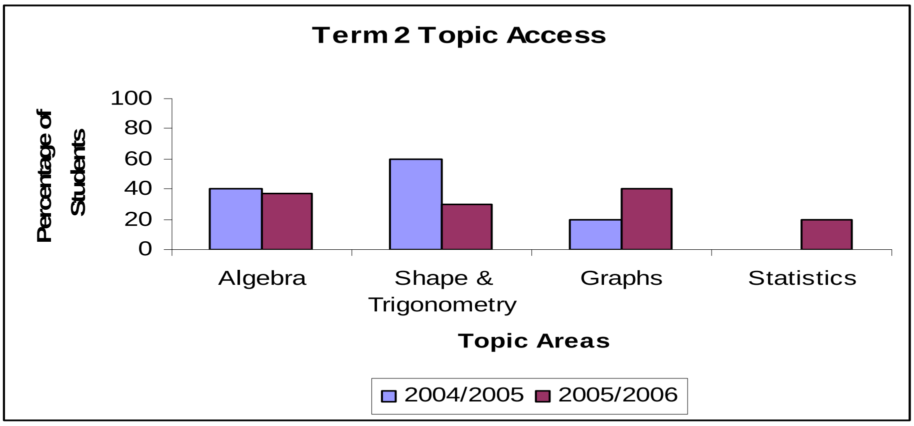

Figure 7.19: Comparison of Cohort's Topic Access in Term 2

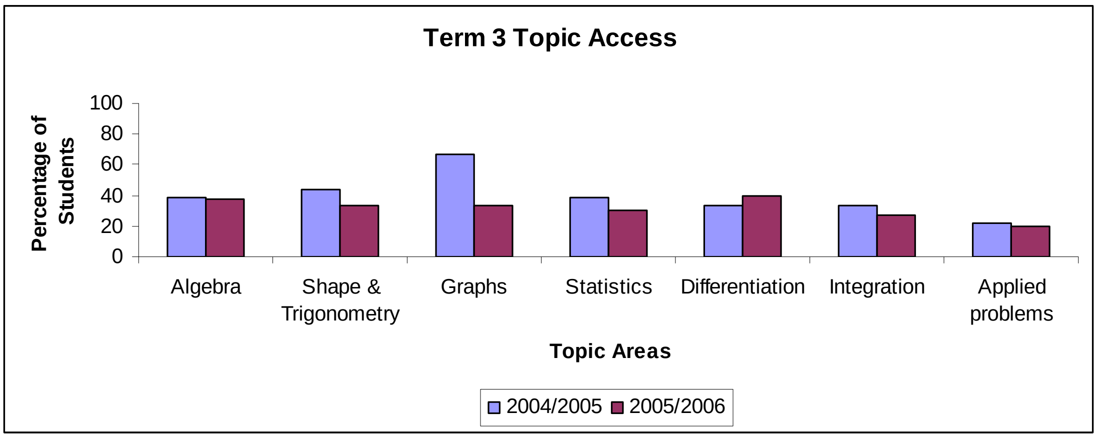

Figure 7.20: Comparison of Cohort's Topic Access in Term 3

The most popular lessons to view in 04/05 were volumes in term 2 and algebraic graphs in term 3. In 05/06 these became simultaneous graphs in term 2 and trigonometric differentiation in term 3. There were eight lessons in term 2 of 04/05 which were not viewed at all. None of the statistics topics were viewed, despite some students being told to learn the statistics topic from the VLE; and only one graphs lesson was viewed; whereas only one algebra and one shape and trigonometry lesson were not viewed. In 04/05 a student did not use them directly for her mathematics, but used them to top up her knowledge for another subject area as described below.

> *"I looked at vectors briefly because I needed it to revise for Science".*

In 05/06 some students were using the resource to pre-empt some of the future work as well as looking at what they had already done. There were still those who were just looking at the resource materials *"out of curiosity"*, but others were using the mathematics resources to help them in other subject areas, such as Key Skills. There were several students who accessed it for this purpose. They were quite specific as to which lessons they needed to look at, as shown below.

> *"I only used it for Key Skills and I looked at standard deviation and variance. All I did was to print off the Blackboard lessons from the PowerPoint slides".*

In 05/06 the majority of students who used the VLE resources looked at the algebra lessons. Not only did the students find this topic area difficult but they also had to be able to apply their knowledge of the topic area under examination conditions. The initial subject area that the groups all started with was algebra, so for them to use the resources for this initially agrees with the findings that this was one of the topic areas that many of them had found very difficult.

The students who were interviewed in 05/06 did not access the resources any more often than the 04/05 students. Their reasons for access were the same, as well as their reasons for non access. Similar topic areas were causing problems with both cohorts. The 05/06 cohort had better accessibility to the resources from the start of their courses, though. Overall, the part time students made greater, and more varied, use of the VLE resources and the internet, than their full time counterparts, who had easier access to both their lecturers and other students on the same course. Both the Electrical/Electronic students and the Telecommunications students used the VLE resources more readily than the Manufacturing and Mechanical students, but all of the former students lecturers had resources available for them to use, whilst the latter students had limited resources available on the VLE.

7.4.2 Viability of VLE

The potential uptake for the mathematics resources in the long term needed to be viable from several viewpoints – financially as well as effectively. The attitude of the students to using this type of resource needed to be determined as the resources need to meet their needs, as well as meeting the requirements of the College and other bodies.

Although the use of the VLE is covered by College policies and targets, it is the students who determined whether it was a viable resource by their use (or not) of the resources posted on it. Although students often used the internet they did not always identify mathematics as an internet subject, nor did they necessarily regard the VLE as internet based. The results in Tables D.9 and 10 clearly demonstrate the mixture of opinions. The views regarding learning mathematics from the internet varied from group to group and from year to year.

There were less at the start of the academic year and this increased over the year. Table D.10 gives the reasons behind these opinions. The positive responses included revision, past experiences, different explanations, the ability to work in your own way and at your own pace, ease of use and accessibility. The negative responses included insufficient depth, lack of one to one support, lack of internet access, lack of ICT skills, distracted by other sites and a preference to use books. Also, *“no interaction”, “depended on topic areas”* and *“never tried”* were responses linked to “don’t know” answers.

Table D.11 looks specifically at the mathematics resources made available on the College VLE for these cohorts of students. In 04/05, 55% felt it was possible to learn mathematics using Blackboard, but in 05/06, the believers had risen to 70%. However, the reasons indicate some differences. Of those who felt that it was possible to learn from the VLE mathematics resources, the reasons cited were for refresher/recap and because it was easy to understand. Those who felt it was not possible, all cited the need to have a lecturer to explain, demonstrate, and bring to life, the new concepts that they were meeting.

When students were asked whether they would be inclined to use an internet resource, specifically written for their course, the majority agreed that they would “reluctantly” use it. There were only 14% (term 1) and 16% (term 2) for 04/05 and 7% (both terms) for 05/06 who were enthusiastic enough to say that they would “definitely” use it. The numbers who would use the resource increased over the year. The full figures can be seen in Table D.12.

When asked what methods they would utilise if they needed to practice some mathematics topics, the students ranked their choices similarly. The full figures can be seen in Table D.13. Class notes were the most popular option for practising mathematics, with work sheets and revision sheets being the next preferred options. Using the internet (not Blackboard) was the least preferred option, despite one third of those that answered picking this option. This shows that although the internet is not the most popular choice for all students, there are a large number of them who find it useful, and it was frequently used as a secondary option to other more popular methods.

The mathematics resources were accessed from a variety of locations. These are summarised in Table D.14. The most popular place for accessing the materials was the college. This was true for both cohorts. The 04/05 cohort utilised work place access more than home access whilst the 05/06 cohort utilised home access more than work place access. Some access was purely out of curiosity, to check up on future topics, and just to see what was available, rather than for a particular reason. One part time student was not very happy about the resources because he had tried to use them several times, but *"nothing worked"* for him, due to IT issues. In 05/06, the access to the mathematics resources was very similar to the access in 04/05. However, more students accessed the materials from their work places, and several accessed them from the hotel where they were staying for the duration of the course. The data obtained from the logging system is a minimum value as several of the students downloaded the resources to their pen drives. The mathematics resources were viewed as being valuable. Some full time students also used tutorial sessions to access the resources, as they were actively encouraged to use all of the VLE resources by their course tutor, who was helping with the Moodle trials.

Table D.15 details the factors affecting where the mathematics resources were accessed from. The two most important factors seemed to be time and computer availability. Access costs were of some concern, but this was not seen as a major issue. The reasons given were the lack of availability of the VLE at the start (6%) and the ease of use in lessons and in the hotel where the students were based (3%). Other reasons changed from zero to 3% because "*the link into the VLE is easy*".

The different types of mathematics support preferred by the students are detailed in Table D.16. The preferred mode of mathematical support was individual tuition, with group work being second best. Lessons and notes posted on Blackboard was third choice in 04/05, but second choice in 05/06. Using the internet (not the VLE) was the least favourite method of all. The "other" options were very limited in popularity, but the other options that were noted were advice on books that may be useful, more homework and more mathematics materials like the ones on Blackboard.

In terms of the viability of the VLE, it was the ease of use that was of most interest. The issues that the students raised were more to do with the systems and passwords than with the materials themselves. The part time students had problems with regards to passwords because there was a time delay in them getting the correct password to enter the section of the VLE they required, as stated below.

"For some of the lecturers you have to have a key to access, and it took a week to get the key. This was the only technical problem I had".

The full time students' problems were more to do with the speed of the system. This can be seen from the next statement.

"I haven't found any [problems with the VLE], but I have had some problems with the system being slow.

None of the students from the individual interviews had any problems with using the resources for learning. Their issues were with regards to security passwords, and the speed of the system in comparison to what they used elsewhere.

7.4.3 The Learners' Experience

To produce a viable and worthwhile mathematical resource on the VLE in the long term it was necessary to investigate the students' experiences. This was targeted towards the kinds of support mechanisms that the students would prefer to use, what they found available and how useful it was. The current mathematics resources on the VLE were also considered as a possible element within this support. Other online mathematics resources were also considered a part of this support, but the individual sites and providers were not looked at in any detail. The first step was to find out what mechanisms the students would automatically choose for themselves if they needed support of any kind within mathematics. The responses to this are shown in Table D.17. In both cohorts, there were only a total of 3 students, who would do nothing if they found a topic area in mathematics difficult to understand. This equated to approximately 2% - 3% per cohort. The rest were split between using the VLE for finding a new or different explanation, reviewing or researching further into the topic or getting support from a variety of people. The majority of the students preferred to ask their lecturer, teacher or tutor above all other choices, (50% 04/05 and 52%

05/06), with friends, students or other colleagues as the second choice (16% 04/05 and 8% 05/06). With regards to reviewing and researching, there was a preference for twice as many to use books rather than the internet as a source of information in both 04/05 and 05/06. Of those requiring new explanations, 10% (04/05) and 13% (05/06) wanted a general explanation – just repeating what had already been explained in a slightly different way. The others – (one student in 05/06) - required a simpler explanation or - (two students - one from 04/05 and one from 05/06) - required a more in depth explanation. In terms of support the preference was for working face to face with a tutor so that you could get instant answers to questions asked. Moodle was cited as being a good resource for support, but it was not considered to be the ideal. Also notes taken during class were considered to be very useful and of greater benefit than accessing the VLE resource materials. One of the part time students stated that using his notes was better, and describes why.

> *"Moodle is a very good one [support system], but I found good class notes were the best support system. … I'd get to a certain part of an equation and get stuck and there would be a note in my class work telling me how to progress from one stage of the equation to the next one".*

The full time students were more reliant upon explanations from tutors, as the following statement shows.

> *"A tutor [is the best support system]. They can work face to face and that is best. You can ask them questions".*

For those who had used the mathematics resources on the VLE, there was an open response question for them to give feedback on the improvements that could be made. Their responses are indicated in Table D.18. There were 57% in 04/05 and 41% in 05/06 who fed back that no improvement was needed. There was no single specific improvement that was suggested across the board, just a collection of additional items that would enhance the provision, all of which could be added over a period of time. These additions could be expensive in terms of both time and money as some were more in line with funded professional website resources than College lecturer provisions.

The students were also asked whether they felt that there were any benefits or problems associated with the mathematics resources on the VLE. The results of this are summarised in Table D.19. The different groups all had slightly different views as to what was good and bad about the resource, depending upon their own personal experiences. Some of the points were the same across all groups, however. On the benefits side there were comments that were not just specific to the mathematics resources, but also to the use of the VLE in general. The ability to look at the resources at any time, anywhere appealed to the students, and they felt it to be a good source of extra information. The problems emphasized their view of it being an extra source rather than the main one because it was necessary to have a basic understanding first. They said that some sections needed better (or more in depth) explanations and that there was a need to have support for difficulties encountered with the mathematics. When the students were asked about good lessons that they had used from the mathematics VLE resource, the topic areas that they cited in 04/05 were area, equations and trigonometry, and in 05/06 were logarithms, algebra, trigonometry, standard deviation and graphs. All of the 04/05 students who were interviewed and who had used the resources had nothing but praise for them. They didn’t think that there was anything that needed changing. The format and layout made it very easy to use. The students felt that the explanations had a reasonable amount of detail without sounding too complicated and that they were very accessible even when the subject area had not been studied. This can be seen below.

> *"I liked the simplicity of the lessons and I can't pick one out in particular but it took me through every stage and showed exactly how a solution or calculation was done. I quite liked them".*

They liked the fact that it was possible to print off the lessons to take away and that they could be accessed from anywhere. The only downside was that technical difficulties had made it unreliable initially.

The students did have some suggestions on how to improve the lessons and presentations. In 04/05 they liked the chat facility and messaging, but would have liked to have had some extra worked examples, and extra links to other files to provide more audio and visual experiences. The use of voice-overs was suggested as a useful addition by some and refuted as a potential distraction by others. The colour schemes were disregarded as the students felt they weren't important in terms of mathematics, so they didn't need to be *"sparkly and spangly".* An improvement that was suggested in 05/06 was to make the resources more interactive, and to include some animation in some of the areas. The first improvement talked about giving step by step answers by a "partial reveal" method. The second suggested using the animation to emphasis operations that are presently static in the resources. Other improvements that were suggested were to be able to email the lecturer directly.

> *"There was nothing that needed to be changed, but maybe an addition of being able to email the lecturer about problems would be useful".*

The use of diagrams together with the simple explanations made it very easy to use and understand. The responses to the lessons and to the VLE resources were all positive. The only extra information was with regards to possible improvements that could be added on at a later date to make it better rather than to fundamentally change it.

The same students were then asked to describe a bad lesson that they had used from the mathematics VLE resources. The consensus was that there were no bad lessons. The idea of the resources being added to and having interactivity was mentioned again in 05/06. The idea of having an email to the lecturer available was also raised again as being a good extra feature that the students would like to have. Some of the students contradicted what other students had said previously about the resources. One felt that it wasn't simple enough, as shown.

> *"They are good with the layout, but there could have been more information, like broken it down even simpler".*

Another student felt that there were insufficient diagrams, in complete contrast to what other students had said, as shown below.

> *"But one thing I would say is that there needs to be more diagrams"*

From these statements, it would appear that the students did not agree about the format of the resources. However, on further investigation, they had looked at different topic areas on the resources. The student who had initially said that the diagrams were good had looked at trigonometry, whilst the student who felt there was more need for diagrams had looked at algebra. The difference in simplicity was dependent upon how comfortable the students were with the resources. The student who felt they were not simple enough had one to one support throughout the course from several lecturing staff, and found working on their own quite a challenge.

The user friendliness and ease of accessibility was considered next. This data can be seen in Table D.20. The majority of responses for both cohorts indicated that the resources were both easy to find and easy to access. This was compared to only one or two students who did not find it easy to access. User-friendliness varied with the second cohort finding the system more user-friendly. This corresponded to the improvements made by IT support regards accessibility. Good layout and labels was the most commonly cited reason for the resource being user-friendly. Some students had issues with slow connectivity when accessing the resource away from the college. This was often due to slow Broadband speed or to the use of dial-up modems. There were some differences between the two platforms that were being used in 05/06. This is illustrated by the following statement.

> *"Blackboard was very easy to use, even from home and I had no problems with it at all. It was far easier to find things with. The layout was far better".*

The general consensus for the Blackboard lessons were that they were *"laid out in a way that was easy to read and learn and understand"*, and that they *"didn't encounter any problems using Blackboard lessons".* Inevitably, though, there were a handful of students (mainly part time) who had problems with passwords and site problems. These students had all been enrolled after the start date of the courses.

More than three quarters of the students who had used the resources felt that they made it easier for them to keep up with the mathematics work for the course. The resource was used for revision, to obtain different explanations and extra support. The highest factor was for extra support. This is summarised in Table D.21.

Table D.22 summarises whether the students would recommend the resources to others. The numbers not recommending the resources remained roughly constant throughout the terms and over the two years. However, there were only 2 students who commented that a teacher was better when giving their reason for not recommending the resources, and this was only in 05/06. In 04/05, during both terms, all the reasons were consistent, except for support, which was the highest response. The numbers for each of the reasons were more varied during 05/06. The key values were good information and extra resource. The remaining reasons of support, revision and simpler to understand all received a lower number of responses. When asked about the effectiveness of the VLE resources, in general, several differing points were raised. The ability to get notes and all the work that needed to be completed at home was considered to be very useful, as was the highlighting of schedules and deadlines. In terms of actual work, the resources prepared by the lecturing staff were considered to be suitable as they were simpler to understand than many other available resources. This is reflected in the statement made by one of the Electrical/Electronic students.

> *"The thing I have found about Moodle is that it's like a text book but it's in layman's terms because it is not about justifying a fee from the publisher. It's more effective in many ways than a text book".*

Several of the students felt that the VLE resources were an integral part of College life, and that it was extremely useful when they were able to use them correctly. However, their acceptance of them was determined by how much of their course materials and what other features were made available to them. Even if they did not use the mathematics resources, there was an indication that they felt that the VLE was still useful for other things. One particularly keen student from one of the Electrical/Electronic groups was very enthusiastic in his comments.

> *"It's [the College VLE] used for just about everything really. It's used for notes on lessons, doing online tests; social events are advertised there, you can email the tutors that way. Also there is general information about the college there so if you wanted to go to the restaurant you can get the phone number. There is just about everything really. It's very useful for revision and getting links to find out further information. It's just part of the computer system we use in college".*

In terms of some of the additional features to the College VLE, there was a mixed response. For example, when asked if discussion boards were a useful feature, some students didn't think so because *"I would get sidetracked and not do any work"*, whilst others saw it as an extra method of support because *"you can leave messages for other colleagues and get help from there"*.

There was also a mixed response as to the support that the VLE mathematics resources offered, from those who had used them. Those students who had used the resources regularly, rated them very highly; whilst those who seldom used them, rated them very low. A selection of the students' comments is shown below. The first comment is from a Telecommunications student who regularly accessed the materials, both before and after lessons, and also had easy access to tutor support.

> *"[I would rate the Blackboard/Moodle resource in terms of mathematics support] Probably 10 [out of 10, with 1 being poor and 10 being good] because it really helps you out".*

An Electrical/Electronics student who also regularly accessed the materials between lessons, but had no direct access to tutor help during the week made the following statement.

> *"I have to rate it [the Blackboard/Moodle resource in terms of mathematics support] as 8 because it was very helpful. The only reason I say it wasn't a 10 was because you haven't got that personal support if you were particularly stuck on a subject area. Obviously that isn't the resources fault; it's just the nature of it".*

A Mechanical student who rarely accessed the resources, and had no direct access to tutor help during the week did not rate them as highly. His comment was less glowing about the resources, as shown below.

> *"I would say 3 as I don't really use it. I know we did use it a lot last year, but I didn't find it that helpful. … It was ok for revision, but if I didn't understand it couldn't explain it to me clearly enough".*

The format of the resources did not suit all of the student's learning styles, however. One of the students felt that the lack of someone on hand to explain limited the usefulness of the resources for her. Her comment is listed below.

> *"I used it [the VLE mathematics resources] a bit last year, but I didn't find it all that useful. … It's the same as reading text books – it doesn't make sense".*

The lack of one to one support was cited by most students as the disadvantage of the VLE resources. The following comment is typical of the students interviewed.

> *"The virtual resource is not as good [as the real classroom situation] because you have no-one there if you need help".*

However, the flexibility of being able to access the resources from anywhere at any time was cited as an advantage.   The students felt that this made the system more useful because they could use it *"on their terms"*. One of the part time students' comments sums this up.

> *"In many ways it's less distracting because you can use it when it's more convenient to you when you are at home or at a quiet time".*

Table D.23 summarises how useful the mathematical resources actually were. Of those who responded in both years, the majority thought it would be useful to have reviews or replays. There were only 4% to 5% in term 3 who were undecided as to whether or not reviews or replays were useful. In 05/06 the reasons for disagreeing were because reviewing the work was already something students did (1%), it was not needed (2%), the day was already too long without adding anything extra in to it (2%), and various reasons which all could be summed up by the word ”apathy” (2%). Of those that were unsure, 2% had never tried and 5% felt that it depended upon the individual or the topic area. For those that agreed there were four categories – refresh memory, revision (for examinations), support and catch-up. For both years refreshing memory was the major reason, with catch-up being the least. In 04/05 the revision for examinations was a higher factor than support whilst in 05/06 both support and revision were equally weighted. Overall, the students who used the resources found that they were useful to look at again at another time. The number who did not find them useful was very small. In 04/05 the main reasons stated for the resources being useful were with regards to being able to spend as much time as necessary on them. This allowed the students to gain a better understanding of what they had been doing in class. The resources as a secondary source of information were also regarded as an important factor. However, there were mixed views when it came to using the resources for notes – that was in terms of using the resource information exactly as it was presented instead of taking any class notes. Some of the students found that it was *“easier to understand than my own notes”*, others found it useful to update their notes from the resources, whilst others felt that their notes were more than adequate and the resources didn’t give them any more information. The lack of personal support with the resources was frequently cited as an issue – almost the need to have a lecturer at their elbow in case of problems. It was this that was given as the main disadvantage of the system generally. Most of the students preferred the face to face support from the lecturer, but were also aware that this was not always possible, particularly if they were studying part time. However, all of the students who did not use the resources agreed that they would have used it if they had felt they were falling behind or had missed any lessons.

In 05/06 there was more of a mix of opinions. Several of the students stated that they had used the resources, but did not find them all that helpful. They all explained that the approach did not suit them, and that they preferred to use books and paper and pen techniques. Some of them attributed this directly to their lack of computer use in the first place. As they did not feel comfortable with computers, they were not happy to use them to look up mathematics work. Several of the students did not feel that the resources suited the way that they learned, and that because they had understood the work in class that it was a complete waste of time. Others felt that the resources offered support, but that it was not portable enough, as described below.

> *"I have used a lot of books. … you can easily get a book from the library and bring it with you".*

At the other extreme, there were students who felt the resources were very useful and enthused about what it had helped them with and how. Several cited the lack of any time restrictions. The main attribute that came out of this use was the increased confidence it gave to the students who were finding it useful. They felt that they would not have succeeded with their mathematics if they had not used the resources to help them.

> *"If I ever got stuck … I'd go on to Blackboard. Because there are worked examples on Blackboard you could see step by step what you were doing for each stage, and then follow it to do the exercises I had at home. I got a lot of confidence from using the lessons. It gave me the foundation I needed. If I hadn't built that foundation I think I would have struggled later on in the year".*

It was also beneficial to know how many students had had some other sort of support in mathematics throughout the year. These figures are summarised in

Table D.24. In 04/05, 19% and in 05/06, 9% of the students used some other sort of support. In 04/05 the other support was fairly evenly balanced between home tutoring, parental help, using text books and getting help from other students. In 05/06 parental support remained the same, but work support, i.e. part time students getting extra help from employers or peers at work, and using text books had risen to double the amount, with help from other students and catch-up or retake up to treble the amount, and teacher, lecturer and tutor support up to five times as much. Several of the students also used the VLE mathematics resources for other subject areas. They also used the platform to revise other subject areas if suitable resources were available for them, as explained below.

> *"Several of the subject lecturers had put stuff on there*
> *so I looked at several subject areas for test revision.*
> *That helped really well. It was just very useful".*

Although there were only a few of the students in each year who had had other mathematics support, it was also necessary to know how easy it was to get the support that they needed. This is summarised in Table D.25. In 04/05 57% felt that this extra help was easy to get with 3% disagreeing and 40% feeling it was not applicable. In 05/06 59% felt that it was easy to get extra help with 11% disagreeing and 30% feeling it was not applicable. In the breakdown of reasons, 6% (04/05) and 13% (05/06) felt that extra support was not needed whilst 3% (04/05) and 4% (05/06) stated that their attendance pattern made it very difficult to get support. Of those who did feel that the support was easy to get, the most popular justification was because the teacher/lecturer/tutor, was very helpful and always prepared to help as necessary. In 04/05 this scored 29% and was similar at 27% in 05/06. Students being prepared to help scored 3% and 4% respectively, whilst the theme of "just ask" scored 2% in both years.

The students were asked to rate their mathematical ability at the start of the course, during the second term and again at the end. The results were skewed towards the more proficient end of the scale, as can be seen in Table D.26. In both years, the students felt that their ability improved as the year progressed. When asked to compare their mathematical ability to others in their group, the results still had a positive skew to the scale. This is shown in Table D.27. Their ratings remained the same over the year. When asked to compare their mathematical ability to others of their own age, the results still had a positive skew to the scale. This is shown in Table D.28. In both years, students felt that their ability improved compared to others of their own age as the year progressed. Tables D.29 and D.30 show the way that the students felt about mathematics. The student views were consistent across both cohorts and across all three terms. The most popular options were to slightly dislike mathematics, with half choosing this option, to see mathematics as unimportant, with one third choosing this option, and finding support in the subject unnecessary with one third choosing this option. The numbers feeling this were consistent for both years and did not change substantially during either year. When asked about their attitudes and ability in mathematics, the majority of students felt that their abilities had increased. This was mainly attributed to gaining confidence and having a greater understanding through applying the mathematics to real problems related to the engineering disciplines. Some of the students attributed this directly to the teaching they had received on the course, whilst some of them felt that the use of the technology had contributed to this. A typical statement about the teaching is given below.

> *"My attitude to maths has improved slightly from when I first came here. I enjoy doing maths a bit more now than in the past. … Basically it's just been classroom teaching and learning".*

Another typical statement about the technology follows.

"Yes I think mine has [ability] because when I came back to College I'd been away from any sort of study for three years so that's why. … I suppose using Blackboard helped because you could look at it at home, you didn't need to be in lessons"

In terms of technology this was not limited to Blackboard/Moodle, but also included software packages and calculators.

"Now we can use Excel on the computers a lot to do spreadsheets and graphs. … It takes a lot of the boring stuff away".

Only a few of the students felt that it had any affect on their attitude, but those that did, reported it as being a positive effect. The change from school to college also had a positive effect on the students.

The majority of students found that it was easy to catch up mathematics work, if they have been absent from class, and they usually found the mathematics easy to remember. This is shown in Tables D.31 and D.32. There were only 1 or 2 students per group who found it difficult to catch up or not easy to remember. They were mostly the same students for both cases.

Tables D.33 and D.34 show the way students feel about computers. The student's views about computers vary between cohorts and across the years. Overall the 04/05 cohort disliked using computers more by the end although they saw them as being more important. The 05/06 cohort liked using them more by the end of the year and also saw them as being of more importance. The students were asked to rate their ICT ability at the start of the course, during the second term and again at the end. The results were skewed towards the more proficient end of the scale, as can be seen in Table D.35. In both years about 85% of the students felt that their ability was good or better throughout the year. When asked to compare their basic ICT ability to others in their group, the results had a positive skew to the scale for 04/05, but the results were concentrated towards the average for 05/06. This is shown in Table D.36. Their ratings remained the same over the year. When asked to compare their ICT ability to others of their own age, the results still had a positive skew to the scale. This is shown in Table D.37. In both years, students felt that their ability improved compared to others of their own age as the year progressed. In all of the courses, the students were expected to use computers extensively. When asked whether their ability or attitude towards computers had changed, the majority reported no change. No-one said that either had got worse. Many reported that their continual use had affected any changes, but only one student felt that this was partially due to their use within the mathematics unit. Overall, there were some improvements, partially due to the mathematics, but mainly due to extra use and building confidence through practice. In 05/06, the same findings occurred. Several of the students were very appreciative of the technology that had helped them with the course. This is shown below in a typical statement.

> *"Blackboard has definitely helped because you can do it in your own time and you can go away and do it. … Technology has helped, because if you go back to Blackboard, and using computers, such as Excel for doing graphs and stuff like that".*

Once again, the application of the subject to the engineering disciplines has helped with the positive changes of attitude, and confidence building, as shown below.

> *"My ability has definitely improved. I think applying the maths has helped … It's used very heavily in electronics with all the equations and that".*

The difference between being taught the subject at school and at college was highlighted again as having a considerable effect in the changes. The change from "teach, test, forget", mentioned in earlier chapters, to "teach, apply, remember" has been very important. There were very few students who felt that there had been no positive change to either their attitude or their ability. This was a much more positive group of students than in 04/05 when there was a more equal mixture of opinions. One student did mention a note for caution. Although the students were all very happy with using computers, this could change instantly when they break down or don't work properly. This next statement says it all.

> *"I still find it very frustrating when I can't get them to work".*

The majority of students found that the mathematics resources usually provided them with adequate support, according to Table D.38. There were only 5% (04/05) and nobody (05/06) who reported that it was never adequate. The majority of students found that the mathematics resources helped them to remember mathematics better, according to Table D.39. Only 5% (04/05) and 16% (05/06) reported that it never helped. The students were also asked how they felt about the level of mathematics that they were learning, and how they felt about using computers generally. The student who had commented that he had had a mental block when at school had been very worried about the mathematics at the start of the course, now felt that he was comfortable with the level of mathematics that he was learning, and also that his computer expertise had increased. His comments are shown below. The first relates to his level of mathematics.

> *"I have found that any maths I have had to tackle in the second year quite easy having done the maths in the first year".*

His second comment relates to his level of using computers.

> *"I'd use the internet for specific things like technical data but I wouldn't think to use the internet or computers for general information at all, and for example, using Excel*

to obtain information from data - I would never have done that before the course".

A Mechanical student, who had also had concerns at the start of the course, also felt that his mathematics was now of a reasonable standard. He was also more able to use the computers, despite not using the VLE resources very much. His comments are shown below. His first relate to the mathematics.

> *"Yes I am [comfortable with the level of mathematics] it is a good level. Just it's a lot easier to understand and I feel that I'm getting to grips with it a lot more".*

His second comment relates to his use of computers.

> *"Yes, they are very useful [computers]. You can rapidly find all sorts of information. I regularly use them to look things up".*

One of the Telecommunications students who had struggled at the start of the course, but worked extremely hard to achieve good results, was also comfortable with the level of mathematics. He felt that it was *"what I expected for the course I was on"*. With regards to the use of computers, his comments reinforced the concept of "digital natives" as opposed to "digital immigrants". This concept refers to the younger generation having been brought up with computers so that they don't know how things operated before their invention – hence "natives" – whereas older people have had to learn to use them and adapt to their introduction, they are not second nature – hence "immigrants". He had come to the College straight from school, and was the youngest of all the students interviewed individually. His comment is shown below.

> *"I have been brought up with it [using computers] so I do it automatically".*

The majority of students found the mathematics resources helped them to understand mathematics more, according to Table D.40. Only 5% (04/05) and nobody (05/06) reported that it never helps.

Table D.41 shows whether the students reviewed their mathematics, and why. The majority of students expected to review their work in order to revise for examinations and tests. The least frequent expectation was to review work after every lesson. This was true of the real results with only 17% (04/05) and 23% (05/06) never reviewing their work in term 3. When it came to remembering mathematics, all the students agreed that using the mathematics regularly and applying it helped them to remember it. If they needed to use topics that they had forgotten, then they would look them up. The preferred option was to use their own notes, with the VLE resources being a second option. This is supported by the following statement.

> *"I would use my own notes to help me, and if I needed anything else I would go back and look at the information on Moodle again".*

One of the part time students used it to double check his class notes and to update them on a regular basis. His comments are listed below.

> *"When you write class notes you can sometimes miss quite an important link so I found the PowerPoint presentations very useful. Algebra and calculus were very good and useful to go through again".*

Table D.42 shows how the students expected to revise based on their previous experiences, as this was at the start of term 1. The ranked order of choices was the same for both 04/05 and 05/06. The favourite method was reading through class notes (71% and 69%) with revision sheets the next choice (48% and 40%). Redoing class sheets was not as popular (35% and 38%), but the least favourite was using textbooks (29% and 15%). Only 7% admitted to never revising (05/06 only), but several had other methods that they preferred. These included working with other people (6%), using the internet (6%), self-testing (1%), using their own special revision notes/flashcards (2%), using the College VLE (1%) and using audio via the internet (1%). Blackboard was not offered as a choice for the autumn survey because the VLE resources were something new to the students, unless they had previously studied at the college, although 1% did still choose this as an option under “other”. All of the students practised their mathematics by revisiting the class notes they had made and the question sheets they were given. They did not all review their work after lessons. This depended upon how well they felt they understood the topic. The more they understood, the less they would review. However, they all revised for examinations by practising questions. One of the part time students summed this up in their statement.

> *“The maths skills that I am currently using I don’t feel I need to review because I feel comfortable with it. … If I have to revise maths I go through my notes, whereas before I would have had to have used text books, and I get an example sheet and work through the questions”.*

The statement showed that the students will work at the subject if they feel they need to understand it more, and if they are going to be examined rather than assessed through course work. There is a clear preference to using their notes above everything else. This also carried the implication that the notes that they had taken in class covered everything that they needed to know, so that there was no necessity to use anything else.

Table D.43 shows how the students felt with regards to learning new mathematics topics. The first part of the table for term 1 gives the figures for how they felt when they started the course, but the final figures for term 3 show how they felt at the end of the course. New topics were regarded as anything that the students had not met before, or concepts that went beyond what they had already learnt or come across previously. This was seen to be different from revising topics that they had come across before. With these new topics, in both 04/05 and 05/06 the number of students understanding them straight away fell from their expectations at the beginning of the course, whilst the numbers who felt that they needed further explanation increased in 04/05 but decreased in 05/06.

Table D.44 shows the strategies for catching up missed mathematics lessons at the start of term 1 and at the end of term 3. The most popular choice to catch up missed mathematics lessons was to ask friends to explain at the beginning of the year, or to copy notes from friends. This latter choice was true of both years. The least favourite option was to ask for extra support or help. Table D.45 summarises the strategies the students used when they found a topic area difficult. For non Blackboard users the most popular choices are asking the lecturer in class followed by asking a friend in class. Nobody admitted to doing nothing in 04/05 but 1% and 2% did state that they did nothing in 05/06. The use of the internet and textbooks were the least favoured options. The areas of mathematics that the students had difficulties with were reasonably similar. The usual topics were algebra and calculus. Many blamed their initial difficulties with algebra upon their experiences at school. This was also true of those who had raised fractions as a problem, although fractions was not a specific topic area that was taught, it was implicit within several of the other topic areas that the students encountered. Calculus also caused problems because there seemed to be so many different methods for solving the questions and the students found that this was confusing to begin with. This was confirmed by a part time students' statement.

> *"Integration and differentiation and algebra were my three hardest subjects last year".*

One of the Telecommunications students elaborates on this theme as to why the calculus was so difficult, although he does not call it calculus, he calls it complex algebra.

> *"The complex algebra [was the most difficult]. I found it very complicated and the rules seemed confusing".*

Several of the students referred to fractions as being a problem topic area. They were expected to know how to work with fractions in order to solve more complex problems, but they did not have the required background knowledge or understanding to do this. One of the full time students explained how this problem was overcome for all of them.

> *"Fractions was the most difficult, and that stems from not understanding it at primary school. We went back over it all really, really slowly and went back to basics".*

From this it could be seen that there were a mixture of ways of dealing with areas of difficulties. It also suggests that there should be extra sections within the mathematics resources on the VLE which are not taught, but which support anticipated deficiencies in basic mathematical topics.

The lesson topics requiring support are summarised in Tables D.46 and D.47. There was more need for support in 05/06 than in 04/05. The 04/05 figures were more varied. Access to the new topics, i.e. the ones taught after statistics – differentiation, integration and applied problems – was lower than 05/06. There were no lessons requiring no support in either term or in either year.

Table D.48 shows the support that was needed where students indicated that the support was easy to obtain. The most popular support requirements were for parts of individual lessons and parts of topic areas. There was a greater requirement for both of these in 04/05 than in 05/06. Table D.49 shows the figures for the reasons behind requiring the support. The most popular reason for support was to cover work that was not understood fully. This was the choice for about half of the students. The next most popular choice, with about one third, was to use the support to help remind them of underlying and basic techniques.

In 04/05, when the students were asked what they had expected from the VLE mathematics resources, they agreed that they mainly expected to have the class lesson in note form, together with further worked examples. They only expected there to be the material that they needed to complete their assignments and assessments, and enough information for them to be able to understand topic areas if they had not understood them in class. They all agreed that this was in place. In 05/06, the student expectations of the VLE mathematics resources were very similar to the 04/05 cohort. They expected the lessons to be more of a refresher rather than a means of learning from scratch. As a consequence, there was more satisfaction with them than in 04/05. Students also commented that it was useful to know what the various topic areas are actually used for and that this was also included within the resource notes.

The students feedback on how they had found the VLE resources will help to improve the resources for future students, but it also gave an insight into what areas of the resources were most useful, and why. Some of the students used it as an extra source to continually visit, whilst others used it more for revision purposes. Algebra and calculus were the topic areas that were mentioned the most in terms of usefulness. There was a clear difference between the students interviewed in 04/05 and 05/06. In the 04/05 the students used the mathematics resources for a greater variety of reasons, but their views were more clear-cut. They were either for or against the resources, but in 05/06 the students reported a more positive outcome from their use, and although there is still a divide between those who felt that they are useful and those who do not, there was also a group who were prepared to use it if it became necessary or if it was made compulsory. Overall, the majority of the student interviewed in 04/05 had increased their ability by applying the mathematics, and a few of them had also improved their attitude towards the subject. The reasons given varied from the inclusions of applications, better understanding, changes of teaching style, and the use of technology both as a support and as a means of removing tedious tasks. So the overall conclusion was that for most students the VLE resources were a very useful and integral part of the majority of courses, but that the mathematics resources were only useful if you accessed them regularly as they were not sufficiently interactive to learn from directly. They were limited in being a source for learning, but they were useful for revising and recapping and adding to your notes. They cannot replace the face to face teaching, but were a useful addition to it. By the end of the first year, the students who were interviewed all felt that they were comfortable with their level of mathematics, despite not necessarily having felt that way at the start. They had all gained in confidence and were more prepared to try to solve their difficulties for themselves.   The use of computers had also increased for those who were not experienced in using them, and this was also seen as a useful improvement. Their attitudes had changed as they became more confident. It did not necessarily mean that they liked the subjects any more, but that they were more able, and more likely, to use them. No single method of support was utilised. There was a mixture of tutor help, self study and use of the VLE resources. Of all of these methods, the tutor help was the most useful for all concerned. The alternative methods of VLE resources and self study were more suited to particular individuals.

7.5 Final Results

The resources are available to help support the students learning. If using the resources help a single student to succeed, then it will have been worthwhile. However, to be cost effective in both terms of time and finance, then measurable improvements should be seen. In order to do this it is important to look at the mathematics results prior to the new resources, during their inception and throughout their use.

7.5.1 Layering

In terms of layering of the subject matter, comprehension was considered to be the progression beyond recall. The interest here was to see if the different approach made the subject matter more accessible so that it was more than just a memory test, and it actually meant something. The easiest way, other than looking at College results, which comes next, was to see where the subject matter has been applied, if at all. More application of the College work was made by the part time students, who actually used it within the work place, as stated below.

> *"I have to control systems. … Before the course I didn't really understand what I was doing, but now I can and if the standard deviation is large I know which specific nozzle on the machine needs to be adjusted. I do use it [the mathematics] quite a bit now".*

The full time students' use was more limited, in that they did not apply it to practical applications outside of their course, being limited to other subject areas where it was used within the course. An example is given from a Manufacturing student.

> *"It was the trigonometry that was applied to the triangle of forces and science. We needed it for the mechanics modules".*

So, the application of the subject was utilised, but to varying degrees, with the part time students having a greater opportunity to explicitly use the topic areas within their work role.

As part of the layering effect, it was also necessary to look at the student results. To be successful, the students should have achieved to at least the same standard as their ability predicted. When questioned about this, all of the students agreed that their final result was a true reflection of the standard they had achieved at the time. However, there were some differences with regards to prior attainment and future attainment. One of the part time students, although agreeing retrospectively that his grades reflected his ability at the time, felt that he would not have predicted this at the start of the course due to issues from earlier experiences at school. He felt that he had achieved beyond his original expectations.

> *"My maths ability increased ten fold because of this course. Mainly because I overcame the mental block I left school with".*

One of the full time students also agreed that her grades reflected her ability at the time, but having used the subject further during the second year, she felt that her understanding had increased, so her expectations for the future would be higher.

> *"I understood it [mathematics] better later and this reflects the grade when I took it but not my level of understanding now".*

In terms of results, all of the students felt that their grades were accurate, and fair, but that they had moved on substantially from their starting points, and would be better placed to improve further in the future.

7.5.2 Results Trends

Pre 2002/03, the full time students consisted of mainly 16-18 year olds straight from school, and a large cohort of overseas students sent by their government. This latter group rarely had the option of referring or withdrawing open to them, and as such, this helped to drive the success rates up for the full time students. Post 02/03, the full time students were not particularly successful. This is because the Telecommunications course regularly has high referrals and no distinction grades and the Manufacturing course had a similar trend of high referrals. There is no longer the cushion of foreign full time students masking the full time results because the contract to deliver this provision has expired. Both groups had students without the necessary entry qualifications who were enrolled to ensure a viable group size.

For all of the graphs shown in Figures 7.19 to 7.25 there is a vertical line which splits the graph into the pre 02/03 and post 02/03 syllabi. This helps to make the trends clearer. The shaded section of the graph indicates when the mathematics VLE resources became available to the groups. The combined results of pass, merit and distinction for each graph type are included as "success".

From Figure 7.21 it can be seen that the withdrawals and referrals post 02/03 have increased whilst the pass levels have dipped most severely.

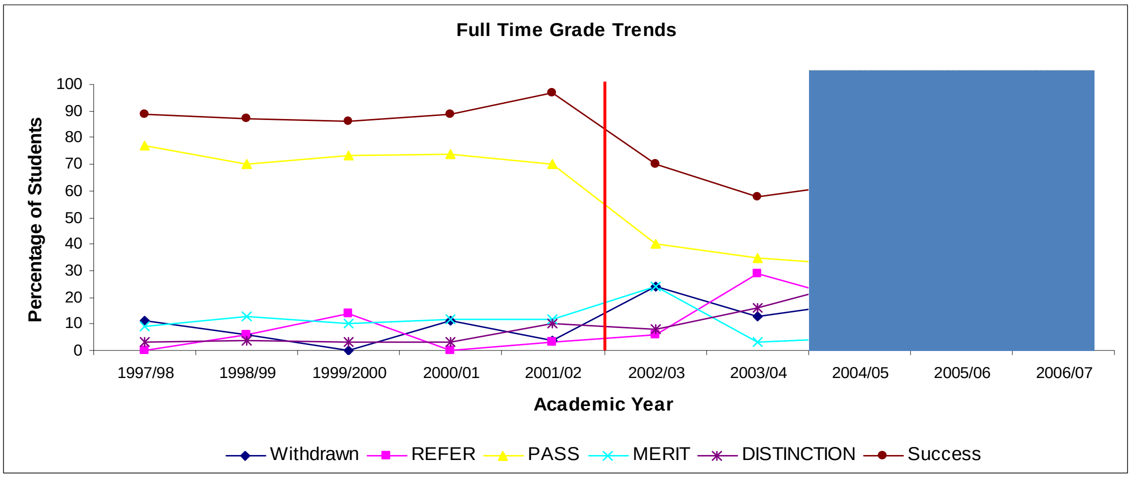

Figure 7.21: Full Time Students Final Grades in Mathematics

Pre 02/03 the referrals had a maximum in 1999/2000 which is similar to the post 02/03 referrals, but the pass rates remained substantially higher throughout the earlier period with the different syllabus and grading techniques. The VLE resources do not seem to have made any difference to the pass rates.

The picture is not quite the same for the part time students. From Figure 7.22 it can be seen that the withdrawals and referrals for the pre 02/03 syllabus are approximately the same throughout the period. However, the reduced pass rate is similar to the full time groups.

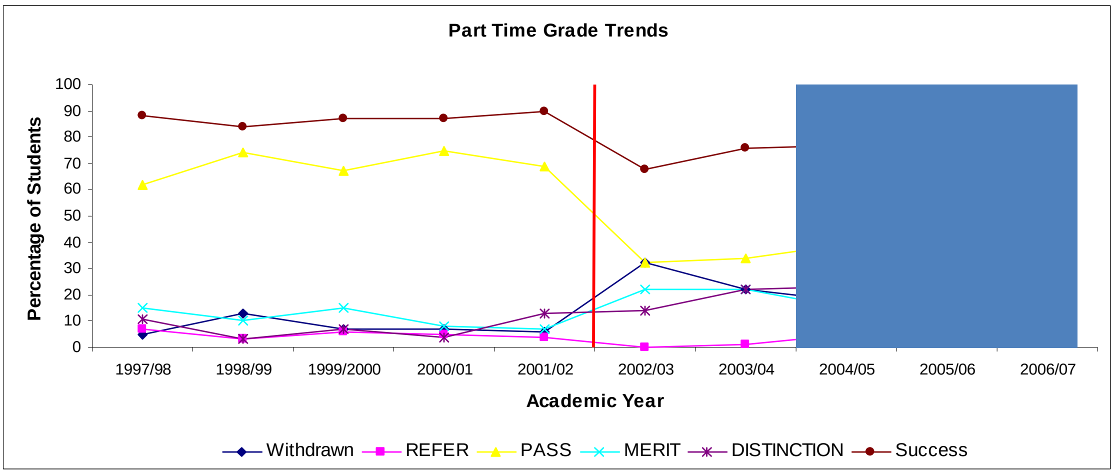

Figure 7.22: Part Time Students Final Grades in Mathematics

Overall, the part time student trends are consistent with high pass levels and low referral and withdrawal rates. However, for the post 02/03 syllabus, the final number of withdrawals is substantially lower than at the start of the new standards. Overall, the part time student trends are good so far, with withdrawals dropping, referrals steadying and passes improving. Also, the Mechanical group statistics are spread over two years so it appears that they have a higher drop out rate than the other courses. In comparison to other part time courses this is true, but is more in line with full time student progressions. More part time students are passing the unit and with higher grades. As the majority of the full time students would prefer an apprenticeship to progressing to university, this reflects their incoming qualifications. The VLE resources seem to have improved the pass rates of the part time students.

If both full time and part results are combined, the overall picture can be seen. Figure 7.23 shows the combined results trends.

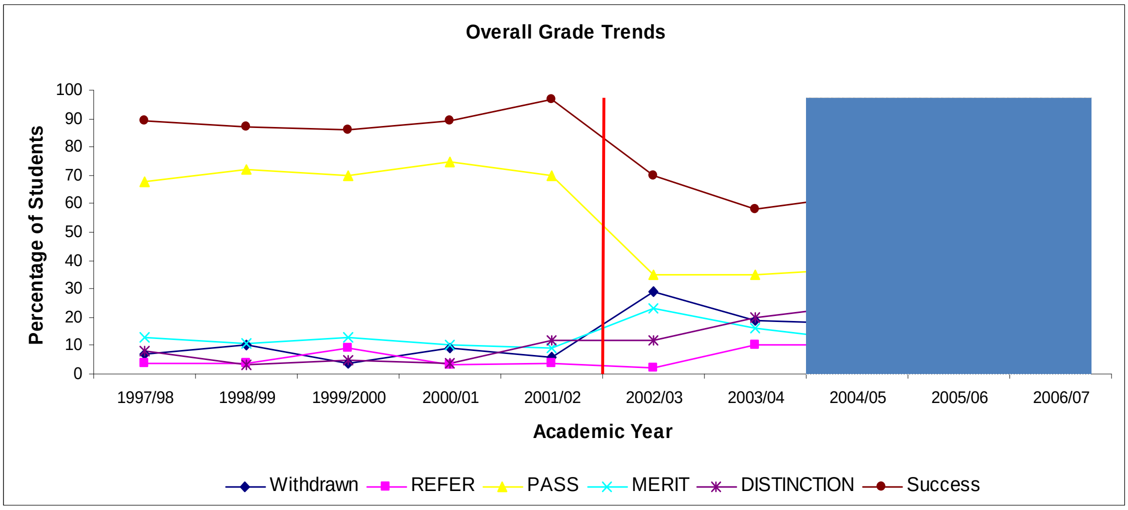

Figure 7.23: Overall Final Grades in Mathematics

Pre 02/03 syllabus, both the withdrawals and the referrals have remained fairly steady, but are above the 5% expected value. The passes, merits and distinctions all show consistent levels throughout the period. Although there is not a problem with the number of merits or distinctions it would be expected to have slightly higher values for both of these. Taking all the results together hides the problems with some of the courses. Overall the picture is good. For the post 02/03 syllabus, the withdrawals have steadily decreased over the time period whilst the referrals have risen over four of the years and then fallen for the last. The referrals still need to be reduced. It is expected that withdrawals should take up the entire shortfall and that all students remaining to the end of the course should pass. At the moment, this is still not the case. However, overall there are more students succeeding since the change of syllabus. The VLE resources do seem to be making a difference.

7.6 College Policies

The next area for consideration is the various College polices that affect the outcomes and how they are measured. Over the past ten years there has been a substantial shift in what is expected of colleges and their results. The pre 2002/03 standards were set in a period when students enrolled on courses, either through their own or their employers choice, did their best and either achieved or didn't. There was some level of additional support available if required, but the automatic mechanisms that are expected now were not in place then. High student withdrawal rates were not considered to be a problem – they "dropped-out" because they were lazy, not up to standard, or not on the right course. There was no push to get them through as there were no penalties for non achievement. Referrals were viewed in a similar way. Support would be offered, but it was up to the student to do something about the problem, rather than being the responsibility of the College. However, there was a feeling that it was better to withdraw than to refer. Success was only reported in terms of the percentage of students passing. In terms of students, there was also a different approach to assignment and assessment work. Grades were dependent on completing the entire task in the first place, and the level of grade would depend upon the accuracy and depth of the answers.

By the time the 02/03 standards had begun, there was a completely different approach to student results. All of the courses had national benchmarks with specified retention, achievement and success figures. Success rates were to be used to decide upon college funding and their financial accessibility banding. This meant that a change of attitude towards withdrawal and referral was required by all concerned. It was now imperative that any student enrolling on a course had a high chance of passing at the end as withdrawal and referrals affected the reported end statistics negatively. The new assignment and assessment system effectively created a situation in which students could omit work for higher grades if they wished; as it no longer affected their ability to pass. Also student support mechanisms became a norm, rather than an extra.

7.6.1 Retention, Achievement and Success Rates

The government specified exactly how retention, achievement and success would be measured post 02/03, and the calculations that were required for the statistics that were to be reported. The calculation methodology is shown in Table 7.2.

Group Data Example 15 Starts, 2 Withdrawals, (13 Completers); 3 Refers, 6 Passes, 3 Merits, 1 Distinction, (10 Achievers)	
Pre 02/03 Standards	**Post 02/03 Standards**
Retention = (Completers ÷ Starts) x 100 = (13 ÷ 15) x 100 **= 87%**	**Retention** = (Completers ÷ Starts) x 100 = (13 ÷ 15) x 100 **= 87%**
	Achievement = (Achievers ÷ Completers) x 100 = (10 ÷ 13) x 100 **= 77%**
Success = (Achievers ÷ Completers) x 100 = (10 ÷ 13) x 100 = **77%**	**Success** = (Retention x Achievement) x 100 = (87% x 77%) x 100 = **67%**
Success and Achievement were interchangeable words for the same value.	

Table 7.2: Success Rates Calculation Methodologies

Although the retention figure is the same, the reporting of the other two figures has had a lasting impact on what happens within colleges generally. As all these figures are recorded and fed into the publicly available OFSTED and College Self Assessment Reports, it is easy to compare whether courses have high drop out rates affecting the results or whether it is through failing the course. The implications of this are discussed further under benchmarking.

7.6.2 Benchmarking Government Targets

All courses for 16-18 year olds and 19+ year olds that belong to the qualification framework and are approved for funding status have a specific benchmark success target. Each individual qualification has its own target. This is a nationally set figure which rises annually. The variance of a course's success from this value determines its grade. There are four possible grades of provision: 1 (outstanding), 2 (good), 3 (satisfactory) and 4 (inadequate).

	Year	Retention (%)	Achievement (%)	Success (%)		Year	Retention (%)	Achievement (%)	Success (%)
All students	1997/98	93	96	89		2002/03	71	97	69
	1998/99	90	95	86		2003/04	81	88	71
	1999/2000	96	90	86		2004/05	82	88	72
	2000/01	91	97	88		2005/06	83	84	70
	2001/02	94	96	90		2006/07	90	94	85
Part Time	1997/98	95	93	88		2002/03	68	100	68
	1998/99	87	97	84		2003/04	78	98	76
	1999/2000	93	94	87		2004/05	82	94	77
	2000/01	93	94	87		2005/06	85	91	77
	2001/02	94	96	90		2006/07	95	98	93
Full Time	1997/98	89	100	89		2002/03	76	92	70
	1998/99	94	93	87		2003/04	87	67	58
	1999/2000	100	86	86		2004/05	82	77	63
	2000/01	89	100	89		2005/06	79	63	50
	2001/02	96	97	97		2006/07	73	79	58

Table 7.3: Success Reporting Using Post 02/03 Reporting Methodology

The individual grades for courses (by age) are combined together into sectors. All engineering courses are graded under Sector 4. This sector also has a national benchmark success target, which is different from other Sector provision. This is the target that has been used with the statistics produced in this section.

The new standards measurement has been applied to all the results, both pre and post 02/03, and is listed in Table 7.3. To make the data clearer, graphs of the data for all students, part time students and full time students have been drawn. These can be seen in Figures 7.23, 7.24 and 7.25. On each of the graphs there is superimposed the benchmark success value of 85%. This is the success value (09/10) that is required to meet good or outstanding in many of the areas. For engineering overall, 80% success is needed for grade 2 (good) status, but 85% (grade 1 – outstanding) is the College's aim. This benchmark figure has been the result of progressive yearly increments until reaching this level. There is also a vertical line superimposed between the change of standards so that the pre and post 02/03 differences are clearer, and the implementation of the VLE resources is indicated by a shaded region. All of the vertical scales start from 50% to show the changes more effectively, whilst still being able to draw a visual comparison.

In Figure 7.24 the pre 02/03 combined data is clearly all above benchmark figure throughout the five years. Therefore the pre 02/03 combined results are good to outstanding by the new standards. The post 02/03 combined success rates fall well below the benchmark figure for success. This would mean that the overall provision is grade 3 (satisfactory).

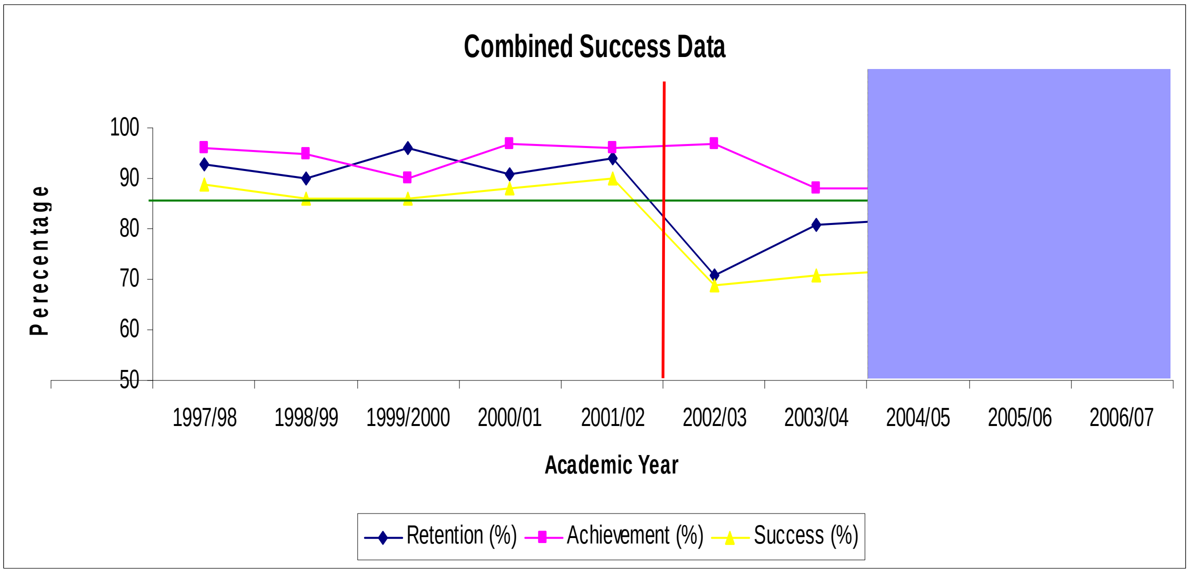

Figure 7.24: Combined Results Using Post 02/03 Reporting Methodology

By splitting apart the full time and part time results it is possible to see more clearly any problem areas. The part time results are shown in Figure 7.25.

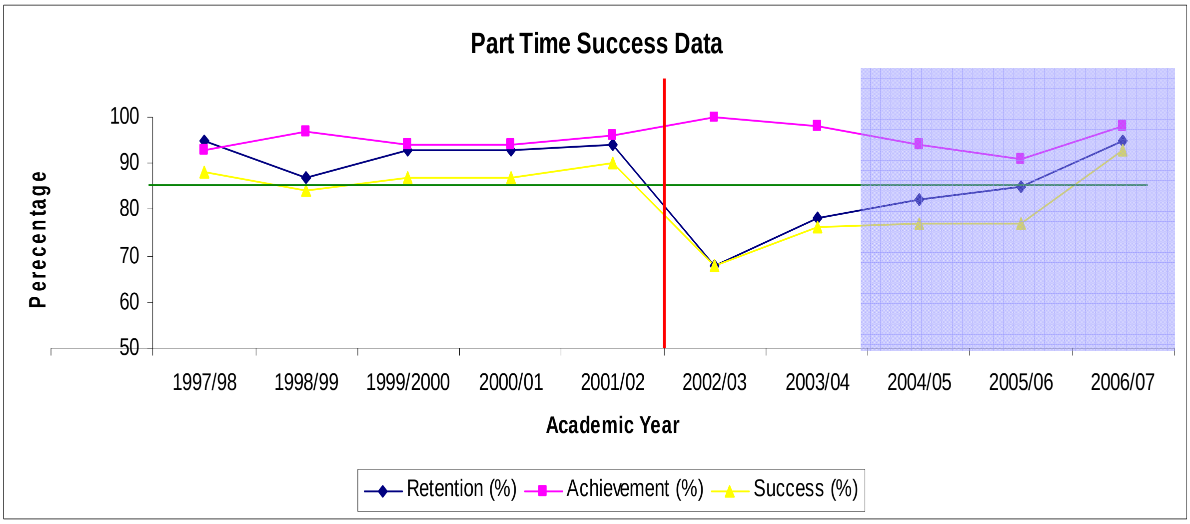

Figure 7.25: Part Time Results Using Post 02/03 Reporting Methodology

The pre 02/03 part time success rates are consistently above benchmarks, except for 98/99 during the five years. This makes the part time provision grade 1 (outstanding) for most of the period. The post 02/03 part time results are only above benchmark in 06/07. The year 02/03 is grade 4 (inadequate) and 03/04 is grade 3 (satisfactory); but 04/05 and 05/06 are bordering onto grade 2 (good). It was in year 2004/05 that the VLE resources began to be used.

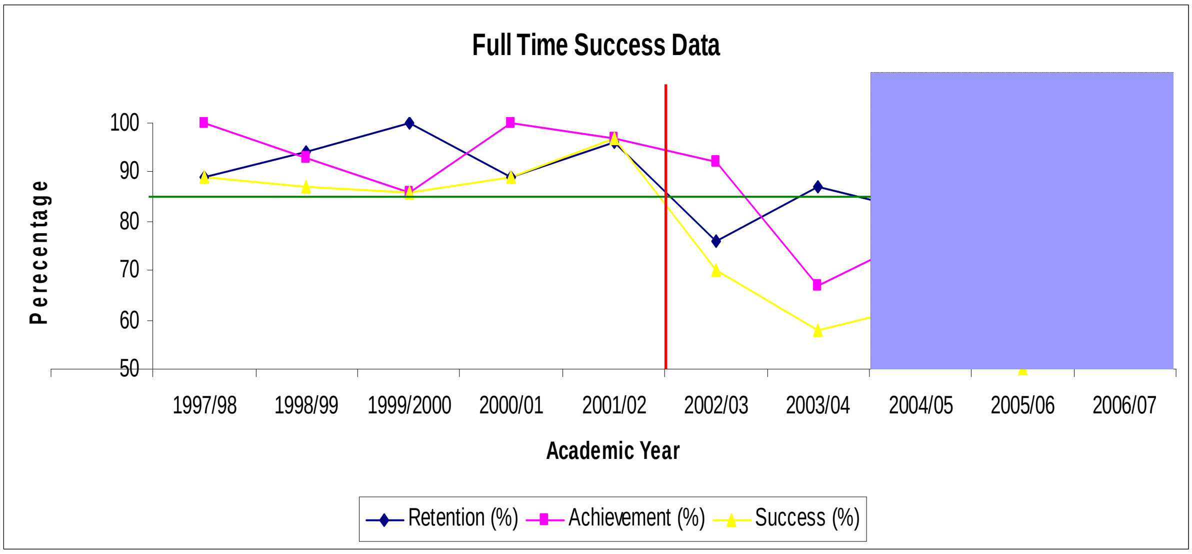

Figure 7.26: Full Time Results Using Post 02/03 Reporting Methodology

Figure 7.26 shows the full time students success rates. The pre 02/03 full time success rates were all above benchmark. These would all have been regarded as grade 1 (outstanding) by the new standards. The post 02/03 full time success rates are well below the required benchmark. They have all been grade 4 (inadequate).

7.6.3 ILT Strategy

The ILT Strategy (Turner, 2002) covered many areas, but the ones of concern for the VLE resources have been tabulated in Table 7.4. From the table it is clear that progression has been made during the life of the strategy, but that not all of the plans have been implemented. Several of the points are still ongoing. The three items that have not progressed – integration of ILT in the curriculum and student access – are down to financial restraints. There is still the desire to implement these, but they are taking longer than was originally hoped. There are still two items in progress – the 1 to 1 PC availability and the linking of the MLE with the VLE and all other College systems.

Reference	Content Heading	Statements Relating to VLE	Achieved (Yes/No/In Progress)
1.2	The Vision for the next three years	Use of VLE as a means of staff to student, student to staff communication	Yes
2.8	Managing the strategy	Curriculum team leaders will develop own plans for VLE material	Yes
3.1	The learning experience	Staff develop use of on-line materials	Yes
		Resource available 24hours, 365 days a year from any computer connected to the internet	Yes
		First modules to be on-line 2002/03	Yes
		Modules to double each year with 500 available by 2005	Yes
		Additional support in use of VLE provided	Yes
3.2	Integration of ILT in the curriculum	All teaching rooms have suitable machines to support multimedia, video conferencing and streaming applications	No
		Internet available in all classrooms	No
3.3	Student access	30% per annum increase for greater open access on main sites	No
3.5	On line resources - VLE	500 course modules available by 2005	Yes
		Available on any PC with internet access	Yes
		Web browser access from anywhere	Yes
4.0	Staff and ILT	1:1 PC availability	IP
		Interactive Whiteboard Technology trials	Yes
		Training – Presentation software, Data projectors, VLE, Integrating ILT, Broadcasting courses on the web, etc; FERL Practitioners Programme – Transforming Teaching and Learning with ILT	Yes
4.7.11	ILT & curriculum teams	IT resources developed over next 3 year	Yes
		VLE use increased	Yes
		Web based delivery more common using on line video and streaming technology	Yes
5.2	MLE development	MLE to link with VLE and all other College systems	IP
5.3	Security	Single unique log-in and password	Yes
		Rationalise user authentication system	Yes

Table 7.4: Summary of Progress with ILT Strategy 2002/05

The 1:1 PC availability for staff is not yet fully implemented, but all full time staff do now have their own PC or laptop available. The MLE development is such that the MLE links with the VLE and all other College systems is not fully integrated. Once again, parts of this have been implemented, but both changing needs and increasing costs have been limiting factors. The first is now correct for all full time staff, but some part time staff do have to share, depending upon their contracted FTE (full time equivalent) status. The MLE is linking with some of the systems, but not yet all of them. This will change as the software systems improve and are implemented. This is a task that is being worked on both within the College and through outside sources. All other statements relating to the VLE have been implemented; although the “staff develop use of on-line materials" is clearly an on-going item. Despite the fact that 500 modules had become available by 2005, not all of the courses have a VLE presence. The take up in some areas has been extensive, but in others it is minimal. To overcome this, there is now a College requirement for every course and unit to have material posted onto the VLE. This requirement is quite specific and provides a measurable minimum standard that is expected and all teaching staff are to be checked against this as part of their performance reviews from 2009.

7.6.4 Learner Policy

The Learner Policy (2004) covered many areas, but the ones that may have an impact upon the use of the VLE resources have been tabulated in Table 7.5.

Reference	Content Heading	Statements Relating to VLE	Achieved (Yes/No/In Progress)
P20	College Charter	Aim to improve student achievement and success annually	IP
		Aim to improve students' experience of learning	IP
		Aim to improve student satisfaction	IP
P21	Student Charter	Agree to take responsibility for organising your own learning	IP
		Agree to use your time to learn to the best of your ability	IP
		Agree to make full use of the resources available including the libraries, computer facilities, learning support services and Student Services.	IP

Table 7.5: Summary of Progress with College Learner Policy 2004

From the table it is clear that progress has been made, but that it is an on-going process. Due to the annual influx of new students there will always be an on-going nature to this particular policy. However, it should be noted that in the 2009/10 Student Handbook, under the section 'Helping You to Study' the item entitled 'The learning resources service' lists *"access to the internet and the student intranet (Moodle)"* as the first in its list of a range of resources to help learning. The final sentence within this item is *"Inductions are also available on Moodle".* This item is immediately followed by the item entitled 'Moodle'. This describes Moodle in a short paragraph.

> *"Moodle is a virtual learning environment where you can get access to software packages, on-line resources and course materials. It is not a program that can replace face to face teaching, but a facility to support teaching with a range of flexible on-line tools, as well as providing a place to upload course materials."*
> Page 15 CCP (2009).

Also, under the section 'Having Your Say' the first item concludes by referring the students to a *"Talkback"* scheme which is there for compliments, comments and complaints. This is explained later in the booklet, but the form to complete is available on-line via Moodle, and the web access reference to this is also given. There is a final reference to Moodle in the footnote relating to item 5 under the 'Misconduct' section. This suggests that students should *"see the Student intranet (Moodle) for full details on plagiarism."*

From the extra references and positioning of the items, it is clear that the use of the VLE is no longer considered as an extra item, but is clearly regarded as an integral part of College life as well as any College course from 2009 onwards.

The College policy with regards to the ILT Strategy (2002) and the Learner Policy (2004) expected staff to use the VLE to post their course materials and for the students to make use of them. The experience of the students should be the same across all courses. However, it was clear from their responses that this was not the case. Better use was made of the VLE by the Electrical/Electronic and Telecommunications lecturers, as can be verified by the following statement from an Electrical /Electronics student.

> *"Every single lecturer has put some resources on to Moodle. Some are obviously larger than others but everyone has something on Moodle".*

This was echoed by a Telecommunications student. The use by the Mechanical, Manufacturing and Fabrication lecturers was variable. A Manufacturing student's statement confirmed the inconsistencies of provision.

> *"Not very many of the lecturers [have resources on Blackboard/Moodle]. Those that do have lots of stuff there whilst others have nothing at all".*

The Fabrication course only ran for the one year (04/05), but this should not have been an excuse as all the teaching materials still had to be prepared.

With regards to student use, there was also an imbalance as to how much the students were encouraged to use the VLE materials. This imbalance was a reflection of the use that the lecturers made of the VLE. Those that made use of the VLE encouraged student use; those that didn't use the VLE didn't encourage the students to use it either. The emphasis of its use was also variable, depending upon which lecturers were involved with the programmes of study. Both the Electrical/Electronic and Telecommunications students said that all of their lecturers encouraged them to use Moodle. The variability of encouragement was encapsulated in an Electrical/Electronic student's statement.

> *"All lecturers have mentioned Moodle but some are more specific in pointing it out. Mathematics - as a way of revising and further examples and tests, Electronic Principles in the first year, Health and Safety specifically, Three Phase Motors and Drives, and Applications as well. There has been lots of stuff on Moodle that has been mentioned to us. Business Systems for Technicians - we were reminded that if we needed to catch up any notes that they were on Moodle, but that was pushed less".*

With the Manufacturing students, a different picture emerged. There was encouragement from the staff that used the resource, but very little encouragement from the others. This can be seen from the following statement.

> *"Our tutor has lots of resources posted and he encourages us the most to use it. The others don't seem to worry about it and don't push its usefulness".*

From this it can be seen that the utilisation of the VLE by staff was not meeting the ILT Strategy (2002) in full, and as a consequence the Learner Policy (2004) could not be met in full by the students, either. The student experience was not the same across all of the courses, despite some units being offered across all engineering disciplines.

7.7 Summary

This chapter has detailed the findings and results from the subjective data gathered through the questionnaires, group interviews and student individual interviews. It has also looked at the results obtained from the objective data and summarised it by using graphs, tables and charts to give a pictorial overview. This chapter began by looking at the entry qualifications of the students and the implications that these had on potential success. The next area that was looked at was the use of the VLE, taken from the computer logging records. This was followed by a general overview of the personal views and expectations that have been gathered from the students. Following this was an in-depth look at students' final results for the past ten years – five prior to the new standards of 02/03, and five since the new standards.

Finally the chapter looked at the impact of College policies such as the ILT Strategy and Learner Policy as well as the imposed policies of benchmarking and government driven statistical measures for success. The conclusions based upon this commentary are discussed further in Chapter 10.

CHAPTER 8

MEASURING THE IMPACT

8.1 Introduction

Having considered the rationale behind the use of the VLE, students' perceptions of the VLE mathematics resources, and the measurable outcomes for the College with regard to success rates; the next step was to consider any measurable impact on both individuals and particular groups of students.

The first section of the chapter looks at student misrepresentation of use. This is discussed because there may be a pattern that arises here which links back to the differences between the different study modes, disciplines, or tutor groups.

In the next section use and non use of the VLE are looked at in detail from a quantitative perspective. The pass rates for a number of different categories of students are considered. The results are used to examine whether the use of the VLE has had an impact on student pass rates.

The final section consists of case studies taken from categories where the quantitative data indicates that the students have a higher pass rate when they use the VLE. This will specifically consider evidence of any benefits and reasons for both use and non use of the VLE.

8.2 Misrepresentations

Some students claimed to have used the VLE resources and hadn't accessed them at all, whereas others had stated that they had not used the resources, but the computer logging system showed otherwise. By looking at the groups concerned it may be possible to draw conclusions as to why they had misrepresented their use. The data is shown in Table 8.1. For each group, the survey totals give the number of students who stated in their questionnaires that they had used the VLE resources and the log totals give the number of students who were electronically recorded as accessing the system by the VLE platform's inbuilt recording system. The difference between the numbers stating that they used the system as opposed to those who were logged as using the system is given in the difference row. Positive results show that there were more electronically recorded users whereas a negative difference shows that there were more who said they used the resources than actually did.

04/05 Total *N* = 112 **05/06 Total *N* = 125**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Survey Totals	3	3	5	6	7	6		4	4	1	3	2		1	1	8	1		0	8	0	
Log Totals	4	7	11	13	8	8		6	3	0	9	1		0	2	13	3		4	9	0	
Difference	***1***	***4***	***6***	***7***	***1***	***2***		***2***	***-1***	***-1***	***6***	***-1***		***-1***	***1***	***5***	***2***		***4***	***1***	***0***	

Plus 5 second years

Table 8.1: VLE Resource Usage Summary

From the table it is clear that no groups accurately reflected their use of the VLE resources when questioned. The majority of groups reported that they had not used the resources when the automated computer log-in system showed that they had. The Fabricators were the only group to accurately report their non use of the resources. The Mechanical groups were the only ones to say that they had used the resources more than the log-in system showed. Of those who stated that they had used the resources less than the log showed, only the Telecommunications group showed a lower difference in the survey results for

05/06. This was a reflection of their tutor's attitude that the resource was an essential part of the course and should be used wherever possible.

All of the groups had been encouraged to use the VLE mathematics resources, but the Mechanical groups had less other material on the VLE than students from other subjects. The negative differences could be because they felt that saying they had used the resource might help them to gain better grades. This was probably because the researcher was involved with teaching and assessing the subject area, and the students may have hoped that their replies would be taken into consideration in some way. The other groups were more dependent upon the age of the students. The younger students were more likely to say that they hadn't used the resources because they were embarrassed to admit that they had used them. This is reflected in the high differences for the Telecommunications group in 04/05 and the Manufacturing group in 05/06. The Electrical/Electronic group A consistently under stated the usage in both 04/05 and 05/06. This group contained younger students than the other electrical/electronic groups.

This shows that to be most effective the use of the VLE resources has to be seen to be part of the delivery rather than as additional to it, even though it is meant as support. By including it within the delivery there is no peer pressure preventing students from using it openly. If students have to access the resources in order to complete work during classes and for assignment work this removes the negativity of "needing support" and the potentially negative attitude of peer group pressure towards "wanting to do well".

8.3 Computer Log Evidence

8.3.1 All Students

By considering all of the students to begin with, it was possible to identify any trends that emerged, which were then looked at in more depth. The main question considered was whether using the VLE made any difference to passing the mathematics unit. In order to do this the students were separated into whether they used the VLE or not, and whether they passed the mathematics unit or not. Those who did not pass included those who withdrew, those who referred at their first attempt and those who failed outright.

	Used VLE	**Did not use VLE**	***Total***
Passed	84	92	*176*
Did not Pass	16	52	*68*
Total	*100*	*144*	*244*

Table 8.2: Comparison of VLE Use and Final Result for All Students in Both Years

Table 8.2 clearly shows that 72% of students passed the unit, but that the students using the VLE had a higher pass rate overall, with 84% of students using the VLE passing compared to 64% of students not using the VLE. This suggests that using the VLE has a positive impact upon student success rates.

The VLE was available for longer during the 05/06 academic year. This would suggest that there should have been a greater impact in 05/06 than in 04/05 due to its extra availability. The academic year 04/05 has been considered first.

	Used VLE	**Did not use VLE**	***Total***
Passed	44	46	*90*
Did not Pass	1	28	*29*
Total	*45*	*74*	*119*

Table 8.3: Comparison of VLE Use and Final Result for All Students in 04/05

Table 8.3 shows that in 04/05, 76% of students passed. Of those who used the VLE, 98% passed compared to a 62% pass rate for those who didn't use the VLE. The VLE use had a greater positive impact in this year, despite the fact that it was not available at the beginning of the year.

	Used VLE	Did not use VLE	*Total*
Passed	40	46	*86*
Did not Pass	15	24	*39*
Total	*55*	*70*	*125*

Table 8.4: Comparison of VLE Use and Final Result for All Students in 05/06

Table 8.4 shows that there was a 69% pass rate overall in 05/06, which was a little lower than the pass rate in the previous year. Of the students using the VLE, 73% passed whereas only 66% of those who did not use the VLE passed. Although the impact of the VLE was not as great in this year it still clearly showed that the VLE users did better. So, despite there being a greater availability of the VLE in 05/06, the impact was greater in 04/05. However, this still clearly showed that the VLE users did better in both years. The reasons for this need to be explored; is it because these students would have passed anyway? This was explored further by looking at different groups of students and in particular the students who did not satisfy the entry requirements for the course. These have been labelled as "non-qualified".

8.3.2 "Non-Qualified" Students

The statistics above showed that VLE users did better than non users. The question which arises from this is whether or not this has anything to do with the VLE. If the students who are passing by using the VLE were more likely to pass in the first place, then this does not prove anything. To investigate this further the "non-qualified" students were considered. Any students who did not satisfy the mathematical entry requirements for the course, but were given a place, have been identified as "non-qualified" and are now considered.

	Used VLE	**Did not use VLE**	***Total***
Passed	22	3	*25*
Did not Pass	4	31	*35*
Total	*26*	*34*	*60*

Table 8.5: Comparison of VLE Use and Final Result for All Non-Qualified Students in Both Years

Table 8.5 shows that 42% of the non-qualified students passed the mathematics unit. The pass rate for the non-qualified VLE users was 85% in comparison with a rate of 9% for the non-qualified students who did not use the VLE. In other words, nearly all the non-qualified students using the VLE passed whilst nearly all the non-qualified students not using the VLE did not pass. Thus the VLE use had a greater positive impact upon success. The question from this is whether or not the mode of study – full or part time – made any difference to the use. Part time students are considered in more detail in the next section with the full time students being considered in Section 8.3.4.

8.3.3 Part Time Students

It is interesting to note that in the 04/05 year the maximum number of accesses (18) were by a part time student who passed the mathematics module, as opposed to the 05/06 year where a full time student who passed the module accessed the resource for a maximum of 52 times. This was in direct contrast to a part time student who said that they *"Have just never heard of them"* and a full time student who said that they *"Have better things to do than use the VLE resource"*. Both of these students did not pass the mathematics unit. This raises the question as to whether or not the non VLE users are unmotivated students. Unfortunately, because these numbers are so low, it would not be sensible to break them down into separate years for further investigation.

Originally, the VLE was regarded as a possible solution to help support part time students, who had a particular demand for extra support. If it is meeting this demand, then the figures should reflect this, and there should be a higher VLE use by part time students compared to full time students. It would be best to start by looking at all of the part time students together to see if there is this trend.

	Used VLE	**Did not use VLE**	***Total***
Passed	63	73	*136*
Did not Pass	4	32	*36*
Total	*67*	*105*	*172*

Table 8.6: Comparison of VLE Use and Final Result for All Part Time Students in Both Years

Table 8.6 shows that the pass rate for the part time students was 79% overall. Of those who used the VLE 94% passed compared to 70% who passed, but did not use the VLE. The VLE use had a great impact despite only 40% of the part-time students using it. Of those using the VLE who passed, the comments were that it was *"Good to revise lessons, particularly if you missed them"* and also to help with organisation *"I used the VLE resources to organise myself and to go through questions with paper and pen and using my calculator"*. Those who passed but did not use the VLE were either very negative towards it *"I thought it was all a waste of time and I didn't see the point as I was already good at the subject"*, or felt that it wasn't appropriate for them *"I had already gained enough information in the lesson so I didn't need to use the VLE resource"*. The non users who did not pass had either *"Never heard of the VLE resource"* or had already decided it was not for them *"I need a teacher to explain it personally"*. This does suggest that there may be a 'floor', i.e. that you need to know a certain amount in the first place before the VLE can help. Once again, this was taken forward by considering the part-time student qualifications at the start of the course.

	Used VLE	**Did not use VLE**	***Total***
Passed	14	0	*14*
Did not Pass	1	16	*17*
Total	*15*	*16*	*31*

Table 8.7: Comparison of VLE Use and Final Result for All Non-Qualified Part Time Students in Both Years

Table 8.7 shows that overall 45% of the non-qualified part time students passed the mathematics unit, but while there was a high pass rate for those using the VLE (93%) none of the students who did not use the VLE passed The only non qualified students to pass were those who used the VLE. This seemed to be down to several reasons. The most common reasons were an increase in confidence *"I got a lot of confidence from using the VLE lessons"* and having unlimited time to study the materials *"Using Blackboard helped because you could look at it at home, you didn't need to be in lessons"*. In terms of those who did not use the VLE and also did not pass the most common reason was lack of time, *"Not enough time to look at VLE resources"* and the preference to be working with a person *"I normally go to the teacher for advice"*. Unfortunately, the numbers are too small to be able to break this down further. However, it was interesting to ask if there was any difference between 04/05 and 05/06?

	Used VLE	Did not use VLE	*Total*
Passed	34	32	*66*
Did not Pass	1	14	*15*
Total	*35*	*46*	*81*

Table 8.8: Comparison of VLE Use and Final Result for All Part Time Students in 04/05

Table 8.8 shows that in 04/05 81% of part time students passed. The pass rate for those who used the VLE was 97% compared to 70% for the students who didn't use the VLE. Again the VLE use had a great impact on pass rates. Students who used the VLE resources and passed found that they were useful – *"The VLE was quite useful if you missed a lesson, you could catch up quite easily"* and *"It does help when you've got it all laid out in front of you as well as having a teacher explain things. It gives you two different sources"*. However, those who passed but did not use the VLE didn't see that it might be useful – *"I feel that being taught by a teacher is better than using technology or computers or anything like that. I'd rather get taught by a person"* and *"I can't be bothered, I'm not struggling, so I don't need to"*.

	Used VLE	Did not use VLE	*Total*
Passed	29	41	*70*
Did not Pass	3	18	*21*
Total	*32*	*59*	*91*

Table 8.9: Comparison of VLE Use and Final Result for All Part Time Students in 05/06

Table 8.9 shows that in 05/06 78% of part time students passed. The pass rate for those who used the VLE was 91% compared to 69% for the students who didn't use the VLE. The VLE had a great impact again, with very similar results to the previous year. However, looking at those who did not use the VLE, but who passed; revealed that their success was more down to using different methods, rather than just not bothering. Some found using the computers difficult as they had limited access to them *"You don't really get a lot of time to be able to just flick through so I preferred to use stuff that I had to hand rather than trying to get access through a computer"* whereas others made more use of other support that was available to them *"I attended extra mathematics support sessions"*.

The impact of the VLE use was great in both years. In 05/06 the employers had requested that extra mathematics support sessions be put on in the evenings as an addition to the VLE resources for the part time students. This clearly impacted upon the VLE use in that the part time students made lesser use of the VLE by attending the sessions instead, rather than as well as, using the VLE. These results show that the VLE resources enabled non qualified students to achieve success. They also show that where there is specific teacher led support that this is preferred to using the VLE resources. The use of the VLE resources has clearly had a positive impact on part time student success, and particularly in the case of "non-qualified" students.

8.3.4 Full Time Students

Having looked at the part time students, it was considered appropriate to check the same ideas with the full time students to see if the trend was similar. To begin with, it was thought best to consider all of the full time students.

	Used VLE	**Did not use VLE**	***Total***
Passed	21	19	*40*
Did not Pass	12	20	*32*
Total	*33*	*39*	*72*

Table 8.10: Comparison of VLE Use and Final Result for All Full Time Students in Both Years

Table 8.10 shows that the pass rate for the full time students was 56% overall. Of those who used the VLE 64% passed compared to a pass rate of 49% for those who did not use the VLE. Although the impact of the VLE was not as large for the full time students in comparison with the part time students, it still clearly showed that the VLE users did better. The VLE use for the full time students was slightly different in that the students who passed were looking at explanations rather than the whole set of information *"Mainly looking at the explanations of how to do the maths rather than the practical stuff"* and *"If there was something I didn't understand very well, then clearly I understood it better after I had looked at the VLE resources".*

Of those who did not use the VLE but passed other forms of support were preferred *"I prefer private tuition to using the VLE"*, or none was used at all *"I was going to use the VLE resources and I thought I would, but even though I was meant to I didn't get round to it"*. On closer investigation the VLE users who did not pass did not really use the VLE, they merely accessed it *"All I did was to print off the lessons from the PowerPoint slides"* or left it too late in the year to turn their results around *"If I didn't understand something I would leave it until it arises in a past paper before using the VLE"*. The non users who did not pass were mainly unmotivated students *"I can't be bothered to use the VLE resources"* who did not understand that they needed to take action when they didn't understand the topic they were studying *"If I get stuck I would do nothing really".* The best way forward is to consider the students qualifications at the start of the course, as before.

	Used VLE	Did not use VLE	*Total*
Passed	8	3	*11*
Did not Pass	3	17	*20*
Total	*11*	*20*	*31*

Table 8.11: Comparison of VLE Use and Final Result for All Non-Qualified Full Time Students in Both Years

Table 8.11 shows that overall 35% of the non-qualified full time students passed, but that there was a much higher pass rate for those using the VLE (73%) compared to those not using the VLE (15%). Once again, the VLE users did much better. However, the reasons for non use of the VLE for students who did not pass were down to lack of time *"I just didn't have the time to look at them properly"* or a poor attitude *"Lessons are long enough without having to use the VLE as well"*. Unfortunately, the numbers are too small to break them down further. However, it was interesting to investigate if there was a difference between 04/05 and 05/06?

	Used VLE	Did not use VLE	*Total*
Passed	10	14	*24*
Did not Pass	0	14	*14*
Total	*10*	*28*	*38*

Table 8.12: Comparison of VLE Use and Final Result for All Full Time Students in 04/05

Table 8.12 shows that in the 04/05 academic year 63% of the full time students passed, but there was a much higher pass rate for those using the VLE (100%) compared to those not using the VLE (50%). The VLE use had a large positive impact. The VLE users who passed found the resources very helpful, both as a support to keep up with the studying *"I found it was a useful support. Kept up with the rest of the class by using it rather than falling behind"* and also to be able to study it at length in their own time *"The VLE resource was helpful, you can take your time".* Those students who passed but didn't use the VLE were generally able to get immediate alternative support *"If I needed help I only had to ask a couple of questions"*, or had found it unnecessary to use *"I haven't needed to as yet"*, but had not dismissed it as being of no use. This was in sharp contrast to some non VLE users who did not pass. They did not see that the resource would be of any use to them *"Because I feel I don't need VLE maths lessons"* even though they had been advised to use them, and because they had not remembered they were available *"I forgot the VLE resources existed".*

	Used VLE	**Did not use VLE**	***Total***
Passed	11	5	*16*
Did not Pass	12	6	*18*
Total	*23*	*11*	*34*

Table 8.13: Comparison of VLE Use and Final Result for All Full Time Students in 05/06

Table 8.13 shows that in 05/06 47% of full time students passed overall. Of those who used the VLE 48% passed compared to a pass rate of 45% for those who did not use the VLE. The VLE impact was greatly reduced, but the students using the VLE resources still did better than non users. There was a difference in attitude towards the reasons for using the resource between those who passed and those who didn't. Those who passed used the resource to look to the future work *"Keep in touch with the subjects to study in the future"* and to spend time studying *"Predominantly accessed it from home where I spent a lot of time using it"*, whereas those who did not pass used the resources to catch up on work *"I was behind with the work so I used it to try and catch up"* or to make their notes clearer *"My notes were confusing so I used the VLE but it didn't help me"*. Neither of these activities involved engaging with the resources in a significant way.

The VLE users did better in both years. The impact was greater in 04/05 when nearly all of the non qualified users passed and there was a more positive impact on part time success. The full time students also successfully engaged with the resources.

8.4 Higher Grade Achievements

Although the VLE resources have had a positive impact on student success, has it had any effect on the grades achieved? By considering pass grades against the higher grades of merit and distinction in a similar way, it should be possible to see if this is the case.

	Used VLE	Did not use VLE	*Total*
Passed	41	60	*101*
High Grades	38	30	*68*
Total	*79*	*90*	*169*

Table 8.14: Comparison of VLE Use and Final Graded Result for All Students in Both Years

Table 8.14 clearly shows that whilst 59% of students passing did not use the VLE resources, 56% of those who achieved higher grades did use the resources. This would suggest that the VLE resources did make a difference to achieving higher grades. This can be broken down into the two years to look at this in more detail.

	Used VLE	Did not use VLE	*Total*
Passed	19	29	*48*
High Grades	20	15	*35*
Total	*39*	*44*	*83*

Table 8.15: Comparison of VLE Use and Final Graded Result for All Students in 04/05

From Table 8.15 it can be seen that 60% of students passing in 04/05 did not use the VLE resources, but 57% of those achieving higher grades did use the VLE resources.

	Used VLE	Did not use VLE	*Total*
Passed	22	31	*53*
High Grades	18	15	*33*
Total	*40*	*46*	*86*

Table 8.16: Comparison of VLE Use and Final Graded Result for All Students in 05/06

Table 8.16 shows a similar pattern for 05/06 with 58% of students passing without using the VLE resources whilst 55% of students passing with higher grades used the VLE resources.

More students using the VLE achieved better than pass grades in both years, but was this true for all types of student? To investigate this further these results were then split into full and part time students.

	Used VLE	Did not use VLE	*Total*
Passed	9	13	*22*
High Grades	7	4	*11*
Total	*16*	*17*	*33*

Table 8.17: Comparison of VLE Use and Final Graded Result for Full Time Students in Both Years

Table 8.17 shows that 59% of the full time students who passed did not use the VLE resources whereas 64% of those achieving high grades did use the VLE resources. The numbers are too small to split this down any further, but the resources clearly had a positive impact on full time students achieving higher grades.

	Used VLE	Did not use VLE	*Total*
Passed	32	47	*79*
High Grades	31	26	*57*
Total	*63*	*73*	*136*

Table 8.18: Comparison of VLE Use and Final Graded Result for Part Time Students in Both Years

Table 8.18 shows a similar trend for the part time students. Here 59% of the students who passed did not use the VLE resources whereas 54% of the students who passed with higher grades did use the VLE resources. Splitting this down gives more detail.

	Used VLE	Did not use VLE	*Total*
Passed	17	21	*38*
High Grades	17	11	*28*
Total	*34*	*32*	*66*

Table 8.19: Comparison of VLE Use and Final Graded Result for Part Time Students in 04/05

In 04/05 55% of students who passed did not use the VLE resources compared to 61% who achieved higher grades through using the VLE resources. This can be seen in Table 8.19.

	Used VLE	Did not use VLE	*Total*
Passed	15	26	*41*
High Grades	14	15	*29*
Total	*29*	*41*	*70*

Table 8.20: Comparison of VLE Use and Final Graded Result for Part Time Students in 05/06

Table 8.20 shows that 63% of students who passed in 05/06 did not use the VLE resources, but 48% passed with higher grades by using the VLE resources.

Using the resources has helped to improve achievement of higher grades. This was particularly noticeable for full time students in both years; and for part time students in 04/05. The 05/06 results did not show much difference between users and non users for higher grades.

Non qualified students are less likely to achieve higher grades than qualified students, so this is the next area to look at as the results should be more noticeable.

	Used VLE	Did not use VLE	*Total*
Passed	27	57	*84*
High Grades	30	30	*60*
Total	*57*	*87*	*144*

Table 8.21: Comparison of VLE Use and Final Graded Result for Qualified Students in Both Years

Looking at the combined results for both years, as shown in Table 8.21, there are 68% of students passing without using the VLE resources, but 50% of students achieving high grades are using the VLE resources. This would suggest that the use of the VLE resources does not affect the outcomes for qualified students. By breaking this down into the two cohorts, any trends should be easier to see.

	Used VLE	Did not use VLE	*Total*
Passed	8	26	*34*
High Grades	14	15	*29*
Total	*22*	*41*	*63*

Table 8.22: Comparison of VLE Use and Final Graded Result for Qualified Students in 04/05

Table 8.22 shows that 76% of students passing in 04/05 did not use the VLE resources whilst 48% achieved higher grades and did use the VLE resources. This does not indicate any difference for qualified students between using and not using the VLE resources for higher grades.

	Used VLE	Did not use VLE	*Total*
Passed	19	31	*50*
High Grades	16	15	*31*
Total	*35*	*46*	*81*

Table 8.23: Comparison of VLE Use and Final Graded Result for Qualified Students in 05/06

Similarly, Table 8.23 shows that 62% of students passing in 05/06 did not use the VLE resources whilst 52% achieved higher grades and did use the VLE resources. Once again, this does not indicate any difference for qualified students between using and not using the VLE resources for higher grades.

	Used VLE	Did not use VLE	*Total*
Passed	14	3	*17*
High Grades	8	0	*8*
Total	*22*	*3*	*25*

Table 8.24: Comparison of VLE Use and Final Graded Result for Non Qualified Students in Both Years

Looking at the non qualified students a different result occurs. Table 8.24 shows that 82% of non qualified students passing used the VLE resources and that 100% of non qualified students achieving higher grades used the VLE resources.

The resources did not make a difference to the qualified students' achievement of higher grades, but they had a large positive impact on non qualified students' achievement of higher grades.

8.5 Case Studies

The results are clearly showing that the use of the VLE resources has had a positive impact on the students' results in mathematics. In order to investigate why this has occurred, some individual case studies were created to see what themes lay behind the data for students in a number of the categories considered. Rather than just look at qualifications and usage, the information gathered fitted better into three different categories. These were: discrepancies of use where the student claim of usage did not match the computer log; outcomes by passing the module or not passing, broken down into qualified, non-qualified, users and non-users; and interesting cases which produced unexpected or unusual information.

8.5.1 Discrepancies of Use

Several students claimed to have used the mathematics resources when questioned, but the computer logging system showed that they had not used them at all. There were others who filled in their use as "regularly" in the questionnaires, but whose use was very limited. There were also several students who claimed not to have used the mathematics resources, but the system showed that they had. Brief pen profiles are included in Appendix E.

8.5.1.1 Declared Use is More than Actual Use

In both 04/05 and 05/06 a couple of electrical/electronic part time students claimed to have used the mathematics resources, but the computer log showed that they hadn't.

Student 1

This 04/05 student passed with a merit and cited the resources as "*making it easier to keep up with lessons*" as well as being a "*good revision and support*". However, he did not use the resources at all. He disliked mathematics and his main source of support was *"help from the lecturer in class."*

Student 2

This 05/06 student referred, despite "*improving his mathematical ability*" – he was a qualified student. He cited the resources as being "*too long to catch up on*". He too did not use the resources at all, but claimed otherwise. His main source of support was "*help from the lecturer in class*", but he disliked mathematics.

However, electrical/electronic students are expected to access the VLE regularly for all of their subjects and many of their assignments, so to admit to not using the resources might be problematic if it was to be relayed to their course tutor.

Student 3

Also in 05/06 a non-qualified part time mechanical student also claimed to have used the resources. His "*mathematics was poor*", and he "*only revised for examinations*". He said that he "*used the resources in term 3*" and also that he "*attended extra mathematics support sessions*". He claimed that he "*didn't need much support*", despite being targeted to attend the extra mathematics support sessions because he was failing the assignments. He was a very weak student who struggled in all areas, but he also gave up very easily. The computer log showed that he had not accessed the resources, and the attendance register at the extra support sessions showed that he had not attended these either. His employer expected him to make full use of both support resources, so once again, admitting to not using the VLE resources or attending classes might be problematic.

Student 4

In 04/05 this qualified part time electrical/electronic student claimed to "*regularly*" use the mathematical resources. He "*only reviewed work for revision, but needed a lot of support*". He said that the "*support was easy to get because the lecturer always helped"*, but this was "*in class only*". Although he said that he "*preferred internet resources and individual tuition*" he only accessed the resources at College during classes. He accessed the resources to view differentiation, but this was only three times in total over the whole year. However, he had been specifically told to access the resources to improve several areas of his work. This would explain why he insisted he had "*regularly*" accessed the mathematics resources!

- All of these case studies had one thing in common – they were expected to use the resources. This would account for why they had said that they used them.

8.5.1.2 Declared Use is Less than Actual Use

In both 04/05 and 05/06 there were students who declared themselves as non-users, but the computer log did not agree.

Student 5

In 04/05 a part time non-qualified electrical/electronic student who declared himself as a non-user accessed the resources for a limited number of lessons. He felt that he was "*good at mathematics, even though it got harder over the year*". He "*asked for help in class*", but "*only revised for tests*". He did not seem to be very pro-active in his learning. He concluded that he "*needed very little support*" and that "*the internet was a stupid way of learning*". He claimed that he "*couldn't be bothered to use the lessons*" and that he "*didn't like having* *support, particularly in mathematics*". His use of the resources is therefore, in contrast to the image he has portrayed. Although this attitude was more akin to the full time students, there were several with this attitude in his group. His employer, however, made it very clear that he was expected to pass the course. In class he followed peer pressure, but in his own time he made sure that he was able to succeed by using the lessons. He passed the unit.

Student 6

In 05/06 this full time qualified telecommunications student also declared himself as a non-user of the resources. The records show that he made extensive use of the resources, and he also said that that the resources "*had a good lot of diagrams*", he "*liked the explanations*", and that the "*step by step information was good*" which revealed an unexpected familiarity with the resources. He "*only had help in class*", and claimed that the "*only work he did outside of class was to revise for examinations*". He said that he "*needed little support as the year was mainly a recap*" of his previous years work. He felt that he "*understood the work well enough already*". His peer group were encouraged to use the resources, so there should not have been any stigma in using the lessons. However, he wanted to do better than just pass – something his peers had not yet taken on board. His secretive use of the resources enabled him to pass with distinction.

- Both of these cases used the mathematics resources secretively. Their peer groups were openly non-users so they both had to use the resources as invisible support in order to achieve their own individual goals.

8.5.2 Outcomes

By looking at students who passed in separate categories of qualified and non qualified this showed whether they had similar characteristics which helped them to succeed. This also considered whether they used the resources to help them and what effect these had. In contrast to this; the characteristics of the students who did not pass were considered, under similar categories.

8.5.2.1 Qualified Students who Passed

Student 7

In 04/05 this full time manufacturing student made good use of the resources. He accessed most topic areas throughout the year and usually spent about an hour on them at a time. Although he "*found mathematics easy*" he was pro-active if he didn't understand. He "*liked mathematics*" and "*pro-actively revised*". He was "*reluctant to use the resources*" because he felt that "*staff support was better*", but he still made use of them for most topic areas. The resources helped him "*to remember and understand*". It also "*provided adequate support when recalling topics*" he didn't grasp. He "*preferred extra group work sessions*", but used the resources "*both in class and at home*". He passed in his first year, but then, using further resource support, upgraded to a distinction in his second year.

Student 8

In 05/06 another full time manufacturing student made limited use of the resources. He was not particularly pro-active as he "*only got help in class*" and "*only revised for examinations*". As the year progressed he "*needed the resources occasionally*" to make sure he "*knew how to do things*". Most of the time he was able to get "*all the support he needed from the lecturer*", but he specifically "*preferred the VLE lessons and notes*" as the "*main extra source of support*" by the end of the year. Being able to use the mathematics resources allowed him to "*sort out any areas of concern*". He passed the unit.

Student 9

This part time fabrication student from 04/05 didn't use the resources at all. He "*found mathematics difficult to understand*", but took a pro-active approach to learning and understanding. Although he "*struggled throughout the course*" he was very pro-active. He felt that his "*mathematics was weak*" so he "*tried hard to overcome this*". He "*did not use the resources*" because he was "*able to get extra support*" from his tutor for all the basic work. He "*did not like using the internet for support*" because he "*liked to ask questions*". He passed the unit.

Student 10

This full time manufacturing student from 05/06 also didn't access the resources. Sometimes he was pro-active in getting help when he did not understand, but his approach was very mixed. He "*needed a lot of support*", but was "*able to get this in class*". He "*only revised for examinations*", but was very pro-active in "*catching up work*". The tutor support he received was "*variable*", but he "*preferred individual tuition*". He "*did not want to use the mathematics resources*" because of this. He passed the unit, but his prior qualifications would have predicted a higher grade outcome.

- The common factor for these students was their pro-active approach to support. The student who was the least pro-active did not achieve as highly as his prior qualification would suggest. The availability of in class support helped all of the students to succeed, but the use of the resources allowed the students to understand and remember their mathematics more easily. It would seem as if they needed the interaction.

8.5.2.2 Non-Qualified Students who Passed

Student 11

This full time telecommunications student in 04/05 needed support. He "*liked mathematics but was not very good at it*". He was very pro-active in "*revising, practising and catching up work*". He would "*always try to understand work*" for himself before getting help. He found the resources "*useful*" because they helped him to be "*told things again*" but he did feel that the "*internet needs online support*". He looked at several topics in his first year, and passed during his first year. He also used the resources during his second year even though the information was only background for the second year course.

Student 12

This part time electrical/electronic student in 05/06 found that the "*mathematics got more difficult over the year*". He felt that "*mathematics was important*" and was pro-active in "*trying to understand*" it. He used the resources because he could "*use them in a relaxed environment with no interruptions on a familiar computer at home*". The lessons helped him with "*understanding and clarification*". The resource was used less towards the end of the course "*as there were other more important subjects*" he needed to study. He "*preferred using the internet and getting extra group work sessions*" for support. He felt that there was a "*need to incorporate assignments which could only be accessed on the VLE to encourage everyone to use the resources*".

Student 13

This full time manufacturing student in 04/05 who "*disliked mathematics*" also "*needed support*". He "*didn't need to use the resources*" because there was "*other support available*". He "*preferred extra group work sessions and help in class*". He was very pro-active in his revision. The internet was not seen as useful because it "*did not give enough information, unlike the lecturer*".

Student 14

This part time mechanical student in 05/06 felt that he "*didn't need support*". He said that he was "*good at mathematics*", despite not being qualified. He was unmotivated and made minimum effort. He passed the unit so his lack of entry qualification may have been due to lack of effort rather than ability, and his view of being good at mathematics may have been correct.

- Once again the pro-activity of the students helped them to succeed, whether this was through using the resources or through other support. The student who was unmotivated seems to have had the ability even though his qualifications did not reflect this.
- The VLE does give an option to pro-active students. If it were not there it may be more difficult for them to get extra help.

8.5.2.3 Qualified Students who did Not Pass

Student 15

This full time manufacturing student (04/05) used the resources. He was "*reasonable at mathematics*", but "*got help during class*". He "*didn't like mathematics*" so he "*only revised for examinations*". He felt that the resources were "*very useful*" and helped him to "*keep up*" and they also "*reminded him of* *things*" he was "*unclear*" about. He would "*recommend the resources to others because they were good*", and they had helped him to both "*understand and remember more*". He had friends at university who "*used a similar system and it worked for them too*". He did say that he would have preferred there to be "*more detail with extra examples*". His "*preferred support was extra group work sessions and individual tuition*". He referred in mathematics, which did not seem to make sense. However, he explained that he had already got an unconditional place on the foundation degree due to prior qualifications and so he "*only needed to study the course for an update*" – he "*did not need to gain any grades*".

Student 16

This part time electrical/electronic student (05/06) used the resources to look at two complete topic areas. He was "*reasonable*" at mathematics but also "*got help in class*". He felt that he "*needed a lot of support*" so was pro-active in "*reviewing, revising and practising*". He felt that the resources were "*very useful*" and that the internet was "*better than a text book because it was more interactive*". He referred in mathematics. This too does not seem to make sense. Looking more deeply into his progress over the year, the areas he looked at on the VLE were the ones he was struggling with. He was due to attend retakes on these during the last month of the course. However, this was the case for several of his other subjects and there were also problems at work. This resulted in him losing his job and he was unable to complete the retakes and so failed.

Student 17

This part time mechanical student in 04/05 felt that he was "*poor at mathematics*" and needed "*extra support in class*". He "*didn't like mathematics*", but was very pro-active in "*revising for examinations through written materials*". He did not think that the resources would be very helpful because he was "*easily distracted*" and "*needed someone to keep him on task*". He also found it "*very difficult to catch up if he was absent*". His absence levels on the course were very high, which mean that he was not very successful. His employer withdrew him from the course so he did not pass the mathematics unit. He may well have been below the depth of the resources in that he was below the 'floor'.

Student 18

In 05/06 this full time manufacturing student who was good at mathematics also withdrew. He had enrolled on the course in the previous year and withdrawn. He had "*help in class*", saw mathematics as "*quite important*", but "*didn't review work in his own time or catch up any work missed*". As his attendance was very poor, he missed a lot of work. The first time he began the course he had stopped attending within 6 months and was withdrawn. The second time he stopped attending within 3 months and was withdrawn. He was capable of passing, but never attended any of the assessments and had a very lazy approach to learning.

- All of the students who did not pass had other issues outside of the mathematics unit. Whilst they were unsuccessful with the mathematics, they were also unsuccessful with the course. Poor attendance is the main criteria, resulting in withdrawal from the main course. The job loss and degree place explain why the users did not pass, but there is also the idea of a 'floor' to the use of the VLE for some students.

8.5.2.4 Non-Qualified Students who did Not Pass

Student 19

In 05/06 this full time telecommunications student accessed three different topic areas through the resources. He was pro-active in getting support, reviewing, revising and practising mathematics. He felt that the internet was "*alright for graphical and written stuff*", but found the resources "*useful and informative*". It was "*simple to use and easy to find*". He even made a copy to take home. He "*regularly accessed the lectures*" from the College library and found "*the match with the lectures helpful*". The resources were "*more than adequate support because of the good written materials*". He felt that he "*couldn't learn directly from them as he needed human support first*". He was referred in the mathematics unit, but his failure doesn't make sense. The only indicator is his comment that it "*got harder over the year and became more difficult to catch up*".

Student 20

In 04/05 this full time telecommunications student withdrew part way through the course. He had not been successful to this point. He did "*revise for examinations*", but this was the only extra work he would do. He "*did not like mathematics at all*". He felt that the "*resources could be useful*", but "*did not use them*". Despite not being qualified, he stated that he was "*good at mathematics and so didn't need any help*". His impression of his ability together with his lack of pro-activity did not help him to succeed either.

Student 21

In 05/06 this full time telecommunications student's view of the resource was that he "*would definitely use them because he could stare at the screen longer*".

He would "*ask for help in class*" if he "*didn't understand*", but he "*preferred to twiddle his thumbs*". He stated that he was "*poor at mathematics but didn't review or practise any work*" in his own time. He was unmotivated and disinterested. He too withdrew from the course part way through the year, but had not been successful to this point.

- All of the students who did not use the resources would not accept that they needed to do anything about getting support in order to pass. The student who used the resource looked at the early sessions and did not review the harder topics at the end of the course. If he was struggling at the beginning, and the course got harder, it could have been too much for him to achieve in view of his very low level of mathematics at the start of the course. This suggests the need to encourage these students to use the resources.

The majority of the students who passed the unit were pro-active in gaining support – whether this was through the VLE or by other means. Not all of the students achieved as well as would be expected, this linked directly to how pro-active (or unmotivated) they were. They liked the interaction of in-class support which helped them to succeed, but the VLE was good to improve both understanding and remembering. All of the students who used the resources but failed the course – either through referral or by withdrawal – frequently had other issues which impacted on their possible success. Lack of attendance was a major factor for withdrawal for full time students whereas job loss was the problem for part time students. Those who did not use the resource and failed the course tended to have an attitude barrier. They did not appreciate the necessity of having support or preferred to ignore that they required it.

8.5.3 Interesting Cases

There were also some unusual and interesting findings from a variety of individuals. In both years there was one student who used the resources significantly more than their peers and it was interesting to find out why. In one year there was one student who was the only person in his group to access the resources, despite them not being utilised by many of his lecturers. There were only ever a few dyslexic students in any year, so it was interesting to see if they had anything different to add. There were also several full time students who failed during their first year, but then passed during their second year, and it was interesting to see if they had done anything differently in order to succeed.

8.5.3.1 Individuals with Maximum Access of Resources

Student 22

Maximum access in 04/05 was made by this part time mechanical student. He accessed the resources on eighteen separate occasions during the year, and he also used them in 05/06 during his second year. Although the student was qualified, he lacked belief in his ability, and rated himself as being "*poor at mathematics*" at the start of the course. He "*enjoyed mathematics*", despite this, and "*improved to good*" during the year. He was very pro-active in his revision, catch up and getting help with difficulties. He used the resources for revision "*because it made it easier to keep up with the work schedule*". Whilst he would recommend the resources for "*further support*"; he did feel that "*individual tuition would be better*". He successfully passed the mathematics unit.

Student 23

Maximum access in 05/06 was made by this full time non-qualified telecommunications student. He accessed the resources on fifty-two separate occasions during the year. Although he wasn't qualified, he was very determined to succeed, and was prepared to try anything to improve his abilities and his chances of passing. He was a very hardworking individual. He was very pro-active towards learning and covered the same lesson several times using the resources to make sure he understood. He preferred to access the lessons from home because he had "*more time available to spend studying them*". He found the resources "*very useful because it was practical, easy to use, and was complimentary to the taught sessions in college*". Using the resources helped him "*to keep up with the work*", but it also helped him "*to prepare in advance for up coming lessons*". Although he felt that "*some lessons needed more detail*"; overall, the "*resources and notes were the best possible support and very accessible*". He successfully passed the mathematics unit, and gained a distinction grade.

- Both of these students were keen to succeed and wanted to do well. As a consequence they were both very pro-active in their use of the resources. Using the resources was a hidden way of getting support. It did not make their extra efforts obvious to their peers nor did it flag up their extra support.

8.5.3.2 Isolated Access to Resources within Group

Student 24

This part time qualified mechanical student accessed the resources when none of the other students in his group did. He found that the "*mathematics was* *getting harder over the year*", and he "*needed extra support*". He felt that he was "*good at mathematics*", but wanted to be sure he would "*pass well*". He was very pro-active in seeking support and catching up work. He got "*tutor support for many of the harder topics, and preferred this because the tutor was reactive on the spot whereas the computer lessons weren't*". He used the resources as a "*reminder before examinations*". He passed with a distinction. He had originally looked at the resources "*because a work colleague on the electrical/electronic course had recommended them*". Although he "*recommended the resources to others in his group*"; they "*did not see the need to use them*".

- This student initially used the resources because of a recommendation. He also recommended the resources to others. Unlike some other students, he did not seem to be bothered that his peer group knew that he was using the resources. He was more concerned about achieving well. He was sufficiently mature that he was able to pursue the support that he needed despite his peer group.

8.5.3.3 Dyslexic Students

Student 25

This non-qualified female manufacturing student made limited use of the resources. She was not particularly pro-active in seeking help or using the provided materials. However, she "*did use the resources for revision purposes*" and found the "*freedom to learn in my own time*" helped her to "*understand more and keep up better*". Her mathematics "*improved over the year*", but she felt that this was due to "*better teaching*" than she had previously experienced. She made her "*own notes to revise*", and had "*different strategies to succeed*" than many of her fellow students. She "*liked the step by step nature of the resource lessons*"; which she said "*provided a good guide*". She would "*recommend the resources as a good recap, but felt that their availability needed to be stressed more*". Although she "*preferred individual support, the resources were very helpful*". She did have problems with the interface. Whilst "*the blue background with yellow worked well as a projected image in the classroom, it was not so good when accessed via the computer screen, - a yellow background with black text would have been better for the support*". She also felt that "*adding in borders and pictures would make the information more appealing*". She successfully passed the unit.

Student 26

This part time qualified electrical/electronic dyslexic student made extensive use of the resources. He was very pro-active in his approach to learning. He, too, found the "*step by step nature of the lessons was very helpful*". The lessons made it "*easier to keep up*" and helped him to "*understand more*". Being able to use the lessons gave him "*more confidence with mathematics*". He did not have any problem with the interface, but "*would have liked more animation for the changes – for example when solving equations or working with transpositions*". He passed with distinction.

Student 27

This part time non-qualified operations and maintenance dyslexic student also made extensive use of the resources. He too had a very pro-active approach to his learning. He "*did not like mathematics very much at the start*", but as he "*became more successful*" with it he began to "*like it more*". Although he would "*recommend the lessons to others*" he did feel that the lessons "*could only* *illustrate and not ensure full understanding*". He "*preferred books as the main form of support*", but this was because "*books could be taken*" with him so were "*always on hand*". He felt that "*not having computer access in every classroom meant that it was not always possible to use the resources alongside the delivered session*". He saw this as a hindrance. He passed the unit.

- The use of the resources by the dyslexic students did not seem to be any different from the other students. They had extra strategies, which did not necessarily link to the VLE, to help them alongside of the resources, but they too were pro-active in their learning. The interface needs seemed to differ between the students, so there should be an ability to alter this for individual use without altering the lesson contents.

8.5.3.4 Students who Passed in their 2nd Year

All of the students who passed in their second year were full time students who had failed the module in the first year. Their access of the resources was limited, or non-existent, during the first year, but all of them accessed the resources during their second year.

Student 28

This non-qualified telecommunications student in 04/05 stated that his "*ability in mathematics was poor*", but he did very little to help himself. He only sought help "*during class*" and only "*reviewed work for examination revision*". He admitted the "*need for support*" but was "*reluctant to do anything*" about it. He referred at the end of his first year. During his second year, his tutor enforced use of the resources by setting him work from them on a weekly basis during the supervised tutorial until he had completely caught up on his first year work.

Student 29

This qualified manufacturing student produced a similar profile. He too "*needed help*", but would only seek help "*during class*". He "*didn't bother to review work or catch up missed lessons*". He was "*easily distracted, would lose concentration, and got bored very easily*". He "*preferred one to one support, but was getting this mainly for reading and writing*". He found that "*the self discipline needed to study in my own time was lacking in the first year*". In his second year he was offered a place on a university course, dependent upon achieving high grades. This seemed to be the motivation factor he needed, and he used all of the resources on a regular basis throughout the year. He seemed to want to understand the work rather than just be able to repeat it.

- Both of these students used the resources extensively in the second year. This more pro-active approach enabled them to pass at their second chance.

Student 30

Another qualified manufacturing student took the attitude that "*mathematics was easy*" and he "*didn't need any support*". He "*didn't review or revise any of his work*". He failed his first year through lack of motivation rather than lack of ability. He had "*extra support through extended lessons*", but "*didn't complete the work*" he was set. He turned this around in the second year by using the resources to help him complete the necessary work. He looked at all of the topics that he had not achieved, and by using the notes and exercises from the VLE he successfully resubmitted new work covering these criteria.

- All of these students seemed to have the attitude that they would pass at

> the end of the year, irrespective of what they did on the course. They had all come directly from schools where the work ethic was externally enforced and were not used to the College system whereby the work ethic was internalised through self discipline. They had not taken ownership of their own actions at this stage. The resources had helped them to turn this around in their second year.

The maturity of individuals helped to overcome the possible peer pressure of being seen to use support. Dyslexic students' use of the resources was no different to other users, although they had extra coping mechanisms that they used alongside the resources to help them succeed. An internalised work ethic through self discipline helps to promote pro-active learning. Using the resources as an intervention tool as well as a study aid is an important aspect. By targeting students to the appropriate lessons in the resources they have a greater chance of being successful with these topic areas.

8.6 Summary

This chapter used contingency tables to draw out the major findings about the use and non-use of the mathematical resources. These show that using the resources had a noticeable positive impact on the success rates of the students. Following on from this, a whole series of case studies were outlined in order to provide a rationale behind the figures. It became clear that the successful students were always more pro-active than those who were unsuccessful, but that peer pressure can be a negative impact factor. By making use of the VLE resources compulsory, as well as using it as an intervention tool, will help to alleviate the peer pressure problem and will enable more students to succeed in the long run.

CHAPTER 9

STATISTICAL TESTING OF RESULTS

9.1 Introduction

This chapter deals with the analysis of the measurable data which was obtained from the questionnaires. The results were statistically tested against the hypotheses which under-pin the six areas of investigation described in the research questions in Chapter 6, Section 6.1. All the tables which give results of the statistical tests are presented in Appendix F. The final overall conclusions are presented in Chapter 10.

9.2 Statistical Testing Methodology

In order to analyse the questionnaire data several different statistical tests needed to be employed. The questionnaires were complex in that they were implemented at three separate times during the year with many questions being repeated, as well as having ranges of answers. This was further complicated by the variety of combinations with the groups which were given the questionnaires. The students were classified by full or part time study, their engineering discipline and their specific tutor group. The statistical tests employed needed to be varied according to both the type of question and the format of the answers received. The statistical tests were all carried out through the use of SPSSv16.

The first factor to be considered was whether to use parametric or non-parametric tests. This was a crucial point, as an incorrect choice would invalidate any findings. Although the parametric tests are more powerful at detecting differences between groups, and there are many more testing techniques available, they should only be used for normally distributed data. Although the data obtained appeared to fit this requirement, it was not of a continuous nature, nor were the intervals necessarily equally spaced. Pallant (2001) states that

> *"Non-parametric techniques are ideal for use when you have data that is measured on nominal (categorical) and ordinal (ranked) scales"*
>
> (P255).

The questionnaire data fitted into this category. For example, although the Likert scaled answers appear to fall neatly into equal intervals, this is a subjective view, and different individuals could easily interpret the intervals differently. The general assumptions for non-parametric testing had to be checked. The tests require random samples and independent observations. With the independent observations, unless use is being made of a "repeated measure", then the individual only counts in one category and cannot be used to affect any others. The "repeated measure" is when the same individuals are re-tested at different times or under different conditions, (Pallant, 2001). As a consequence of this, it was decided that the non-parametric testing would be the most reliable way forward, despite its less powerful attributes.

9.2.1 Non- Parametric Tests Used

From the available non-parametric tests there were several that were suitable to analyse the questionnaire data. The Mann-Whitney U Test was used to test for a difference between two independent groups on a numeric measure. The scores on the numeric variable were converted to mean ranks across the two groups. The Likert scale questions for comparing the full and part time students fitted this format. For the same comparison across three or more groups, as with the engineering disciplines or the student tutor groups, then the Kruskal-Wallis Test performed the same task in a similar way. The Wilcoxon Matched Pairs Signed Rank Test was used with repeated measures when the same students were measured in the same way on two separate occasions. The scores were converted to mean ranks. This allowed a comparison between the first and last questionnaires which all the groups had completed. For the same comparison across all three questionnaires, which was completed by the groups who were present at the College as opposed to those who were at sea or elsewhere with their jobs, then the Friedman Test was used to perform the same task in a similar way.

9.3 Hypothesis Levels for Tests

Before undertaking any of the statistical tests it was necessary to decide exactly what was being statistically examined. In order to do this it was necessary to set up five levels of hypotheses, as defined by Batanero (2000). At level five, the null hypothesis for the testing is too specific to cover the six areas of investigation, which are very broad and encompass the whole study. However, the six areas are under-pinned by four main themes which directly link into any outcomes. These are student ability, student attitude, VLE issues and support. It is the effect of these under-pinning themes that could be crucial to the outcomes of the over-arching areas of investigation. These hypotheses are listed in Appendix F.

9.3.1 Under-Pinning Themes

The under-pinning themes are detailed below. Each of them impacts upon the six areas of investigation, and formed part of the data collection.

Ability: This theme related to how the students perceived their own mathematics and ICT abilities individually, compared to others in their teaching group and to their age group. It also covered whether the students remember work, their reaction to new topics and whether they regard mathematics as being difficult.

Attitude: This theme related to how the students perceived their own mathematics and ICT attitudes towards the subject, its importance and whether support was needed. It also covered whether the students review work, revise, or practise. Absence was also considered and the strategies employed for catching up work were looked at. The concept of learning mathematics via the internet was also examined.

VLE Issues: This theme was only applicable to those who had accessed the Blackboard lessons. This covered the frequency of access, the time spent when accessing, where it was accessed from and any problems with access. It also asked whether the student would recommend the resource to others, what they found good about it, what they found poor about it and how it could be improved. They were also asked whether they found the resource useful or not, and why.

Support: This theme looked further into support strategies. It considered using the materials posted onto the VLE (Blackboard lessons) as a means of support as well as more conventional support strategies. Those who had used the Blackboard lessons were asked whether it had helped them to learn and to understand the work. It also looked at what they had accessed both in terms of topic areas and the amount of use of these areas. Those who had not used the

Blackboard lessons were asked what support, if any, they had used and in which topic areas.

9.3.2 Hypothesis Testing Using Themes

By considering the under-pinning themes, rather than the over arching areas of investigation, the hypothesis testing has more meaning, so the statistical testing will be based around these themes. Using Batenero's approach, then this relates to the questionnaire data as follows:

- Level 1: The emerging themes of ability, attitude, VLE issues and support.
- Level 2: The individual split up of each of the themes into topic areas. For example, the ability theme splits up into remembering, new topics, generally and difficulties.
- Level 3: The split of the topic areas into the individual questions.
- Levels 4 and 5: The statistically stated hypotheses from these questions.

An example of a Level 4 statement was *'The perceived ability of the full time groups is better than the perceived ability of the part time groups to remember mathematics'*, whilst the Level 5 statement would be *'There is no difference between the perceived ability of the full time and part time groups to remember mathematics'*.

The resulting summaries of these hypotheses are listed in Appendix F.

9.4 Hypotheses Results

Tables F.1 to F.9 relate to ability, F.10 to F.18 relate to attitude, F.19 to F.25 relate to VLE issues, and F.26 to F.37 relate to support. Within each of these themes, the tables start with the pretest hypotheses, followed by the key points resulting from the significance testing, and the colour coded significant test results. The conclusions that follow are based upon both the key points arising from the testing and the subsequent drilling down into these specific questionnaire responses.

9.4.1 Ability Conclusions

In both 04/05 and 05/06 there were clear differences between the students' ratings of their abilities across the year. For mathematics, in 04/05 there was a clear divide between the disciplines, with the telecommunications having the most widespread ratings and the mechanical having the least spread. In terms of their own ability the differences were between the tutor groups in term 2. This was based upon their incoming qualifications and experience as well as their progress with the unit to date. There were also differences between terms 1, 2 and 3. In term 1 the students in both cohorts were comparing themselves to students they had studied with at school – where there had been a complete mixture of abilities, with many of their peers continuing into more academic rather than vocational qualifications. By term 2 they had a different set of peers to compare themselves to, and consequently their ratings changed considerably for both cohorts. By the end of term 3 they knew how well they had achieved in the mathematics unit, and this helped to influence their ratings. The disciplines also had different ratings for their own abilities in terms 1 and 3. This reflected a hierarchy of electrical/electronic, mechanical, manufacturing, operations and maintenance, and telecommunications, and was relative to their incoming mathematics qualifications. In 05/06 there was a clear divide between the disciplines, with the electrical/electronic rating themselves more highly in term 1, and both the electrical/electronic and mechanical groups rating themselves more highly than the full time students in terms 2 and 3. Partially this was to do with the level of mathematics expected from them by their employers as well as having to achieve better than their peers in order to get the jobs in the first instance. This was also shown in term 3 by the full time and part time split. The part time students rated themselves more highly against their peers than the full time students did. There were also differences between terms 1 and 3 as well as terms 1, 2 and 3.

With regards to ICT, there was a difference between the ratings of their own abilities in terms 1 and 3 for both cohorts. Many students were not used to using ICT at the start of the course, but were reasonably adept by the end. Although the computer use increased over the year, it was not always directly related to using computers for mathematics. Consequently, many students did not see any link between using computers and being able to succeed in mathematics, and they did not relate this to the use of the mathematical resources that were available through the VLE.

When finding topics difficult, there was also a difference in the kinds of help that the different cohorts chose. Looking up the information in a text book in 04/05 differed between tutor groups as well as across the disciplines in term 1, whereas in 05/06 this was between full and part time students as well as across the disciplines in term 3. This was because many of the part time students had to self study and it was easier to use text books than to try to get help from lecturers, friends or work colleagues in 04/05. Getting help from a friend in class was different for the disciplines and tutor groups in term 3 and different for the part time/full time students and disciplines in term 1. This corresponded to the group attitude and ethos. In 05/06 searching the internet for information differed between part time/full time students, disciplines and tutor groups. This was partially due to the encouragement from different lecturers who were keen on using ICT and the VLE, the accessibility of a computer, the student's previous experience of using this kind of facility, and their familiarity with ICT.

In 05/06 the full time students felt that they were remembering their mathematics better than the part time students during term 2, but by term 3 there was a different split emerging from the tutor groups. This was because the topics to this point (start of term 2) were ones that many of the full time students had met recently in school and felt that they knew, whereas, by term 3, the split was due more to how much effort individual students had put in over the year to learn the application of the subject, and this related much more to group attitude and ethos than prior knowledge or mode of study. There was a difference with both part time/full time and the engineering disciplines regards needing a lot of explanation when learning new topics in mathematics highlighted in term 1. This questionnaire was answered at the beginning of the year, when the part time students, were concerned about the level of mathematics they would be expected to learn, and about how well they would be able to cope with studying on top of a full time job. This contrasted with the full time students, (and their disciplines) who had different expectations, based around their school experiences. This was also reflected in the need for extra help to understand the new topics. The part time students felt that this would be more necessary than their full time counterparts. Once again, this came through in the disciplines. The Electrical/Electronic, Operations and Maintenance, and Mechanical students felt that extra help would be necessary whereas the Telecommunications and Manufacturing students felt that it would not be necessary. However, in term 3, there was a reversal in that the part time students felt that they needed less help to understand the mathematics than the full time students. This was because they had worked hard throughout the year and were better prepared, whereas the full time students had relied too heavily on previous knowledge and had not been used to having to learn new concepts.

9.4.2 Attitude Conclusions

In both years there were differences in the ratings of mathematics by the students. The part time/full time students rated the importance of mathematics differently in both term 1 and term 3. The full time students did not see that mathematics was necessary based on their experience of what they had learnt at school. However, this had changed by term 3 when they had made use of the mathematics in a more practical manner. In 04/05 the disciplines rated the importance of support within mathematics differently during term 3, whilst the tutor groups rated their liking of mathematics differently in term 2. As the year progressed and the mathematics became more applied, the amount of support that was needed by some of the disciplines increased. This was particularly true for the Manufacturing and Telecommunications students, who were not able to relate the experiences realistically as they had no work experience within their engineering fields. In both years, the more difficult the subject became the more it was disliked, and in term 2 many students did not feel that they were making very good progress. Some of this related to the lack of application of the topics, but the main reason was because of the time needed to learn the new topics. Term 1 had been fairly easy in comparison because there had been a lot of revision of topics studied at school, but by term 2 the topics were not only more difficult, but also new. Also, many of the term 2 criteria were judged through in class tests, which were more rigorous than the students had anticipated, despite being given revision of an appropriate standard. A similar profile was found in 05/06. By term 2 the part time students felt that they needed more support than the full time students. This was because they wanted to be sure that they could apply the subject areas in their other classes, whilst the full time students felt that they still had plenty of time to learn the mathematics. However, by term 3 many students had gained in confidence so were beginning to like the subject better. Due to the lack of qualifications at the start, many students had to struggle to keep up, and this was reflected in their attitude towards mathematics.

Attitude towards what the students would do if they were absent varied quite considerably. For the part time/full time students this was with regards to needing extra help and copying notes from a friend in term 3 in 04/05 whereas in 05/06 this was with regards to finding it difficult to catch up and getting a friend to explain in term 1. By term 3 the topic areas were getting more difficult and more applied. Consequently the part time students took a more pro-active approach to catching up than the full time students. In both years this was regards to difficulty in catching up in term 1, whilst for the tutor groups this was regards to ease of catching up, difficulty catching up, and not catching up during term 1. In 05/06 this related to using textbooks to catch up. The Mechanical and Electronic/Electrical students felt that it would be difficult to catch up if they were absent, partly due to their full time work commitments, and partly due to the lack of lecturer explanations. For the Electrical/Electronic, Mechanical, and Maintenance and Operations students the use of a textbook was the first choice to catch up with, mainly because they could not get regular help from the lecturer whilst at work. The results for term 1 all depended upon what students felt that they would do as opposed to what they actually did. Some groups felt that they would not need to catch up as the work would be covered again, like it had been in school, and this linked to their views that it would be easy to catch up. This particularly related to the Manufacturing students. Other groups felt that it would be hard to catch up because the level and amount of work per session was very intense, particularly the Telecommunications group. Across terms 1 and 3 this related to the need for extra help. At the start of the year many students lacked confidence or ability, and felt they needed more support, whereas by term 3 this was more to do with how well the students hoped to achieve. The part time students expected the work to be difficult and were worried that if they missed a lesson they would have problems in catching up. This was partly because of the subject matter, but also to do with the attendance being only one day at the college, limiting their opportunities to catch up. By term 3 many students were re-taking assessments and finishing off applied problems. This meant that more groups needed extra help at this time. Textbooks were also seen as a major source of help at the start of the course, but by term 3 the methods for support had varied, and more use was made of other methods as well. The use of textbooks was reduced over the period as a main reference source, other than for being easier to carry about.

The attitude towards the internet between the tutor groups was different. This related to using the internet to learn during term 2. Also across terms 1 and 3 the attitude towards the use of specific materials written for the course varied. Many of the students did not feel comfortable with using ICT, and so were not keen to use it to help them learn mathematics in 04/05. However, in 05/06 the students did not necessarily like it anymore, but they could see it had some value. Across the disciplines and tutor groups, the attitudes varied, and there was a real mix of attitudes, but there were specific groups/disciplines that appreciated its usefulness from the start. These were the Telecommunications and Electrical/Electronic groups, and both of these groups had a very healthy view of ICT. This also applied to work specifically written for them at the start of the year. However, by term 3, the attitudes of some students had changed through the use made of the resource. In 05/06 there was little interest in the materials at the start, but as the year progressed they became of more interest. Also, as students began to use the resources, their recommendations to others increased their use and the likelihood of their being used. The use of other resources on the VLE by other students from other subjects also helped to encourage the use of the mathematics materials. This was related to the encouragement of their course tutors, and was group and discipline specific.

9.4.3 VLE Issues Conclusions

In 04/05, the accessibility of the resources depended upon where they were accessed from. In terms of having heard about the resource, there were differences between the tutor groups in term 3. This reflected the different use made of the VLE platform by their course organiser and subject lecturers. The more use that was made of the platform in their subject area, the more the students made use of it in mathematics. There were differences in term 3 across attendance modes, disciplines and tutor groups in how easy it was to find the lessons they needed from the mathematics learning resource. This was partly because some students did not access the resource until term 3, and so were unfamiliar with it. This was also due to having to look at the lesson material from the start, and if what they needed was half-way through the lesson they could not fast-forward to this point. This was very similar to the 05/06 students for term 3. The full time students made far more use of the College computers, whilst the part time students not only accessed the resources from home, but also from their workplace. The accessibility from off-site depended upon what types of computer and internet services they were able to use. In term 3 all the students were concentrating upon passing the course, but the part time students were much more focussed on this than the full time students. For the part time students, this was because their employers would expect them to pass, and their jobs and pay levels were linked to being successful. The full time students did not see it as so important because they regarded the second year of the course as the chance to improve or upgrade, so they felt that they had plenty of time to become successful. Many of the higher criteria were revisited in the second year mathematics unit which the full time students studied, which gave them a second opportunity to obtain the higher grades.

The length of time that the resources were used for in term 3 was different for the part time and full time students. The part time students used the resource for longer periods of time than their full time counterparts. This was because the part time students had less availability during the week to use the resource, so tended to concentrate their use into longer time spans. The full time students used the resources more frequently, but for much shorter time spans – just dipping in and out during the week in both years.

9.4.4 Support Conclusions

In both years the resources and support were used differently. Parts of individual lessons were replayed during term 2 and these differed between the tutor groups. By term 3 students had become some selective in picking out the bits they needed to look at. Parts of sets of lessons were replayed during term 3 and these differed between the part time and full time students, as well as in term 1 when the tutor groups differed. The reasons for replaying differed between terms 1 and 3, with ‘not understanding’ and ‘as a reminder of basic underlying techniques' being the specifically differing reasons. The part time students accessed the lessons more for understanding than for revising. Consequently they accessed them more often than the full time students who were using them for revision. Parts of individual lessons were also replayed differently by the part time and full time students, for similar reasons. The individual lessons and main topic areas are summarised in Appendix F.

The term 1 mathematics teaching was used to remind students of the basic underlying techniques, in preparation for the rest of the course, whereas term 3 was used more to look at the more complex applied topic areas that were not initially understood. The individual tutor groups found different areas of the work difficult, and needed to replay different individual lessons. This was also dependent upon which lessons the students had missed, as some tutor groups attendances were not very good. In term 2 there was a difference between the disciplines in their replaying of algebra topics and between the tutor groups in their replaying of graphs topics.

In 04/05 simplifying expressions and solving equations were accessed more by the students with lesser qualifications, and this matched to the disciplines. The trigonometric graphs resource was accessed least by the electrical/electronic students as it was a topic area that they were familiar with through their electronics lessons. Support was needed in term 3 for the integration topic by both the part time/full time students and the disciplines. The area under a curve needed less support by the part time students than for the full time students. This was because the part time students had applied the concepts in their work in other subjects, whereas the full time students had not got to the same stages, due to their lack of practical experience. In 05/06 the Trigonometry and

Pythagoras resources were replayed more by the part time students as they wanted to make sure that they knew the topics well in preparation for an examination. Many of the full time students had already covered this topic in school recently, so were less inclined to study it at this time. Support for transpositions in term 3 was different for both full time/part time students and tutor groups. This was a topic area that caused a lot of problems for the full time students, and particularly the telecommunications and manufacturing students. This reflected their lack of good mathematical backgrounds. Differential equations was another topic that needed different support for the part time/full time and disciplines. The part time students needed more support. The electrical/electronic students had come across this topic in their electronics lessons and knew that it would be needed in the future.

9.5 Summary

This chapter has outlined the reasons for using statistical testing and the rationale behind the use of non parametric testing. The data to be tested was split by the four emerging themes which under-pinned the six areas of investigation. Each theme was statistically tested using a variety of testing techniques, and the significant results were reported. The conclusions which were drawn from these analyses are discussed in detail in Chapter 10.

CHAPTER 10

CONCLUSIONS FROM THE RESEARCH

10.1 Introduction

This chapter draws together the most important results and the consequences arising from these. The results are linked back to the original research questions, but the limitations and any reservations are also discussed in detail. The aims of the overall research question are summed up by the evaluation of both the data and the VLE. The discussions are addressed by the six areas of investigation that arose from the research questions and were outlined in Table 6.1 in Chapter 6, together with the four themes under-pinning the research questions formulated in Chapter 9. The conclusions are all based upon the data that was presented and summarised in Chapters 7, 8 and 9. Finally the overall research aim is evaluated.

10.2 Six Areas of Investigation

This study investigated how the new approach of capturing the lecture and PowerPoint slides; and then posting it onto the Blackboard platform affected both the learning environment and the learners' experience. The conclusions based on each of these six areas follow.

10.3 How the VLE Resources are Used

The VLE mathematics resources were not used by all students, but the majority of students reported their use as "regular". The access increased from 04/05 to 05/06 as students became more familiar with using this type of resource. This corresponds to Forsyth (1998), Frau et al (1992) findings that it is necessary to understand the system first. The first year was a pilot year for both the VLE and the mathematics resources, whereas the VLE was utilised more across the College in the second year, which influenced the exposure of the students to this form of support. The access was limited during the first year by log in problems and the mathematics resources not being available until January. This reflected Reynolds et al (2003) findings about the unreliability of systems having a negative impact. The mathematics resources were accessed most during term 3 in both years. This corresponds to both the more complex topics and to the end of year "catch-up" when the students tried to improve their grades from earlier in the year, as found by Pitcher et al (2002). There was also an attitude change by many of the students towards using computers and the internet. During their first year at the College they had been taught how to use computers to help them with their work, including research. Consequently they were more confident in using them, and so avoided them less as the year progressed. This is similar to the findings of Parsons et al (2009) who found the level of confidence affects student actions. This also explained why the number of students who felt that it would be possible to learn mathematics over the internet increased over the year too.

The part time students used the mathematics resources much more interactively than the full time students. Rather than just browsing through the slides and taking notes, they completed exercises and studied the materials. This was because they did not have the same opportunities to do this during the week. The full time students were able to complete the exercises as part of their tutorials and key skills sessions, so did not have to rely solely on the mathematics resources. The part time students only had the mathematics resources to support their studies outside of their class times. The more interactively the students engaged with the VLE resources, the greater their success became. There was a direct link between how the resources were used and how well the students achieved.

Several of the students downloaded the whole of the mathematics resources to their pen drives. These students could not be tracked whilst they used their pen drives, but they did use the resources extensively. Their rationale for downloading was to make the accessibility easier and to take away the necessity of internet access. This meant that they had greater opportunities to use the mathematics resources. This matches Cook and Timmis' (2002) views of student motivation that the easier it is to access the more likelihood there is of it being accessed. There was no particular type of student who did this – it seemed to be more to do with individual attitudes rather than anything else. They did not necessarily struggle with the subject either – it was seen more as being an "electronic text book" and more portable than written notes and traditional text books. Portability corresponds to Samuels (2007) findings. During the second year of the study the College was swapping over to Moodle from Blackboard. All new students were directed to Moodle. Consequently in 05/06 Moodle was used more than Blackboard. This agrees with the findings of Forsyth (1998) and Frau et al (19992) that students are more likely to use resources they have been shown how to use. The mathematics resources were made available on both platforms and some students would switch platforms if there were down time problems. The volume of use was also greater in 05/06. This was partially due to the mathematics resource being available sooner, but it also corresponded to the greater awareness of the usefulness of the system by staff. The encouragement of students to use the VLE was emphasised during induction, and the students were directed to use it across many different subject areas. The effects of the changes in staff attitudes towards the use of a VLE system are noted by AAMT (1996), Deaney et al (2006) and Samuels (2007).

10.3.1 Why the Students Use the Resources

The mathematics resources were used for many reasons. The students cited extra support, previewing, reminding, revision, assignment work, organising notes, catching up work missed, studying areas not understood, checking for the future, seeing what was there from curiosity, and for top up in other subject areas, such as science. There were also several reasons for not using the resource. The students didn't get around to it, had IT issues, or felt that they didn't need extra help.

In 05/06 the resources were used more for revision and for looking at specific topics within key skills lessons. The part time students used the mathematics resources when they had difficulties, but this was alongside other methods. The full time students preferred to use other methods first – such as asking friends or the lecturer – but they had easier access to these than the part time students did. This reflects Abouserie et al (1992) who found that the resources were an extra support, but not a substitute.

The full time students used the resources to download notes. Often the lessons were looked at to take notes, but the students did not feel that they were using them as they had not been interactive, nor were they trying to understand them. Several were keen to have good working knowledge of the content to build on prior to a lesson. This was because they wanted to feel comfortable in front of their group. Dahler (2009) and Rishi (2007) both confirm that comfort is a key factor to successful learning.

Although the modal access to the mathematics resources was zero for both 04/05 and 05/06, which was possible as they were optional resources, this meant that anyone who did not need to access the resources didn’t bother. This was also linked to those who forgot, were lazy, or did not have internet access outside of college. This relates to the findings of Cook and Timmis (2002) regards student motivation in that the higher the motivation the more likely the students were to access materials. This relates again to the findings of Dahler (2009) and Rishi (2007) who found that convenience was important to successful learning.

10.3.2 Where the Resources Were Used

The mathematics resources were used in and accessed from a variety of places. Some students never used them at all whilst others accessed them from home only, others from College only, others from work places only, and others from both home and college. In 05/06 there was also access from hotels. The most popular access point was the college. The availability of College computers was greater for the full time students than for the part time students. The part time students were only in College for one day a week, with very little time outside of lessons whereas the full time students were in for three to four days with more time slots available to use computers, such as tutorials and key skills sessions, as well as having a greater amount of free time outside of lessons when they could access the computers in the library.

The full time students accessed the resources more from the College whilst the part time students accessed them more from home or work. In 04/05 more students accessed from work rather than home, whereas in 05/06 more student accessed from home rather than work. In 05/06 there was also access from hotels, but this was specific to the Maintenance group who were block release students. They spent the first and last term at College and the second term at sea, and they were not resident to Plymouth. For many of the students in 04/05 their home computers were dial up and this made accessing the resource too time consuming as well as expensive. By 05/06 there were more students who had broadband access, which made home access more reliable, and easier. The offsite access depended upon the types of computer and internet services available.

10.3.3 When the Resources are Used

No one was able to use the mathematics resources in term 1 of 04/05 because they did not become available until the January. There was a higher access rate at the start of 05/06 as the resources were available from September. The greatest use was in April and May which corresponded to the statistics assignment and revision for retests and completing partial criteria. This matched the February and March of the following year. The least use was in March in 04/05 and in December, April and June in 05/06. These all corresponded to holiday periods – Christmas, Easter and summer.

The days the mathematics resources were used corresponded to the days that the students were in college. In 04/05 the majority of the part time students were in on a Wednesday, with only one group in on a Thursday. The access was 43% on a Wednesday, with Monday and Friday being a lot lower, although the resources were used on every day of the week. In 05/06 there was a different split of the groups across the week with the mechanical groups in on a Wednesday, but the Electrical/Electronic groups were split across Monday, Tuesday and Thursday. This change of attendance was reflected in the access to the resources. Friday was the least popular day again. Friday has always been a half day in the local engineering companies, and has traditionally been an evening when many students go out to socialise. In College the morning starts later on Fridays, as there is always a team meeting first thing. This means that the lesson schedule has to be a lot tighter to fit everything in, leaving less opportunity for students to access the resources. The library is also closed during the meeting time as library staff also attend the team meetings, so this meeting slot does not provide extra time for the students to access the College computers.

In 04/05 the access was mostly in the afternoon and early evening. There was also some access in the late evening and at midnight also. The peak time of 6.00 p.m. and 7.00 p.m. corresponds to the part time students' evening break and the full time students arriving home. The 10.00 a.m. and 3.00 p.m. peaks correspond to the full time students' tutorial and key skills slots. In 05/06 the times were more spread out. Several students worked very late in the evening and through the night. The main access was in the early to mid morning, with some in the mid afternoon and late evening. The peaks of 6.00 a.m. and 8.00 a.m. related to access by part time students. The further away they lived from the College the earlier they accessed the resources. This cohort used the resources before College rather than during or after. The 6.00 p.m. slot was not used as much because students were not accessing from off site locations when they didn't visit the College library during their evening break. The 10.00

a.m. slot coincided with the full time tutorial slot again. The odd time of 4.00 a.m. was used by many full time students with no clear reason discernable for the odd time, and part time students who had been working on a night shift. There were clear differences between the patterns of access for the 04/05 and the 05/06 cohorts and a lot of this related to ages for 04/05 whilst in 05/06 it related more to tutor groups.

10.3.4 By Whom were the Resources Used

In 04/05 only the Fabricators did not access the mathematics resources. This was because they were part time and did not have many other units other than the mathematics available on the VLE. Consequently, they were not encouraged to use the resources outside their mathematics sessions. The Maintenance group, which was a very small group, accessed the resources the most, (80%). This was because most of them had easy internet access at their bed and breakfasts, and hotels. This was true for both 04/05 and 05/06 due to their form of attendance as well as their non residence in the Plymouth area.

Although only half of the students accessed the mathematics resources, there were many viewings, which meant that the students who did use them did so frequently. The access was due to age factors rather than attendance factors, as older students accessed the resources more than younger students. This was also partly due to the confidence of the students. Many older students felt that they needed extra support with the subject and used the resources for this – either before lessons as preparation or after lessons for consolidation. The younger students were more confident as they had studied the subject more recently at school. This confirms the findings of Abouserie et al (1992) who found that using resources as a support was more common than as a substitute. It also reflects Parsons et al (2009) findings about confidence levels among students of this type.

In 05/06 the part time groups used the mathematics resources mostly for revision. However, the Mechanical groups' access was very limited. This was due to several factors – they had the least number of other resources available on the VLE, their tutors did not actively encourage them to use the VLE, they were part time students, and the majority of their lessons were not timetabled in computer rooms so they had limited computer access. The Electrical/Electronic group's access was higher. In contrast they were actively encouraged to use the VLE, they had all of their other subject resources available on the VLE, and although they too were part time, they were timetabled into computer rooms. In 05/06 more full time students accessed the resource than in 04/05. The age of the students was not a factor in accessing the resource in 05/06; it was dependent upon which group in which the students had been placed.

However, there were no groups who accurately reflected their use of the VLE resources when questioned. The majority of groups reported that they had not used the resources when the automated computer log-in system showed that they had. The younger students were more likely to say that they hadn't used the resources because they were embarrassed to admit that they had used them. This shows that to be most effective the use of the VLE resources has to be seen to be part of the delivery rather than as additional to it, even though it is meant as support. By including it within the delivery there is no peer pressure preventing students from using it openly. If students have to access the resources in order to complete work during classes and for assignment work this removes the negativity of “needing support” and the potentially negative attitude of peer group pressure towards “wanting to do well”.

10.3.5 What Areas of the Resources were Accessed

The first lesson of “Powers and Indices” was accessed the most, mainly due to curiosity. The students wanted to see what the resources contained and how they might be helpful. Both of the initial topic areas (“Algebra” and “Shape and Trigonometry”) were also accessed by the majority. This was because both topics were assessed by examinations, and algebra was seen as being difficult. This also corresponded to the time when most students did not feel very confident about their ability in mathematics. This was the same for both full and part time students. This matches Hobson and Rossiter (2010) who found students lacked confidence in algebra, trigonometry and calculus.

“Applied Problems” and “Integration” were the topic areas that were accessed the least by all students. These related to higher grades, and many students chose to concentrate on getting higher grades within other units which they considered were more important for their main qualification aim. Several of the full time students studied these other areas as they needed higher grades in order to progress to university at the end of their course.

The part time students accessed “Graphs”, “Differentiation” and “Statistics” the most. All of these topics were assessed by assignments, and the part time students had less opportunity to discuss their methods with their peers. They also self studied more for their examinations as they wanted to pass them first time. This corresponds to Parsons et al (2009) findings about better initial qualifications providing greater confidence levels, as the part time students were usually better qualified than the full time students.

10.3.6 How Frequently the Resources were Used

Although the modal frequency for using the resource was zero, 45% of the students accessing the resources used them more than once. The older students accessed the resources more frequently than the younger students, and this was irrespective of their group or attendance mode. The extreme values (18 accesses and 28 accesses in 04/05; and 52 accesses in 05/06) were all older students. Less than 14% used the resources only once or twice, the remainder used them more frequently. The main range was between 3 to 10 accesses. In 04/05 four accesses was the most common, whilst in 05/06 five accesses was the most common. Also in 05/06 there were an extra 11% who accessed between 13 to 22 times, with 16 being the most common. However, because several students downloaded the resources these figures do not contain their usage as it would not be recorded by the system. Consequently, the true figures were higher than this shows. The successfulness of students was directly linked to their use of the resources, so this matches Sullivan and Mousley (1996) and Asp and McCrae (1999) who found interaction enhances learning.

The students who used the resources more than once were more likely to access them regularly. The 05/06 cohort used the resources more frequently and consistently throughout the year. The access patterns were due to differences in attitudes. Part time students used the resources for extra support because they had limited access to a lecturer. Older students felt that they needed to spend extra time and effort because they regarded mathematics as being difficult, based on prior experiences. Students who used the resources, rather than just browsing through them, found them useful, so revisited them as necessary. The 05/06 cohort had the expectation that they would need to use the resources from the start because of staff encouragement and talking to students from the previous cohort.

10.3.7 The Duration of Use of the Resources

The time spent on the resources was greater in term 3 than in term 2. This was because term 3 concentrated on completing and revisiting all previous work. This was to ensure that they had sufficient understanding to be able to repeat and apply the concepts for the assignments and examinations. This corresponds to the findings of Pitcher et al (2002) about working to improve grades.

When the resources were used for between 5 to 30 minutes at a time, this was for finding information and reading through it to check the main concepts and correct class notes. When the resources were used for more than an hour at a time this was for more than just finding the information and reading through it. This was for engaging with the work and studying it. This agrees with Sullivan and Mousley (1996) and Asp and McCrae (1999) who found it took longer to engage with resources than to read them.

The part time students tended to use the resources for longer periods of time than the full time students. This was because they had less availability to access the resources during the week so they had more concentrated long time spans of studying. The full time students were more inclined to dip in and out of the resources more frequently because it was more available to them. This matches convenience and comfort factors found by Dahler 92009) and Rishi (2007) regards using the resources.

10.3.8 How this Meets the College ILT Strategy 2002/05

The awareness of the VLE and the mathematics resources was the same across the groups, whether they used the resources or not. However, this did increase over the year as the students began to use the resources more frequently. Those who did use the resource regularly were very focussed in what they accessed, and there were very few who *"could not be bothered"* (4% and 12% respectively). This meets the ILT Strategy.

However, within some subject areas there was a lack of resources on the VLE and the students were not encouraged to use the VLE. This was also impacted upon by the lack of computer availability, and insufficient time to access the resources that were there. This does not meet the ILT Strategy.

In 05/06 Moodle was also available, which gave the students a greater choice if one of the platforms failed. The students were also accepted the fact that it was possible to use the internet to help with mathematics – based upon their experience of sites such as GCSE Bitesize. The majority also agreed that they would use resources written specifically for their course which had to be accessed via the VLE. This meets the College ILT Strategy.

10.4 Viability of the Resources

The learning environment secondly needed to address the viability of the VLE platform as well as the mathematics resources that have been posted on to it from the college, staff and students' viewpoints.

10.4.1 Financial Costs of Setting Up the Systems

The implementation of the College ILT Strategy has been expensive, and continues to cost considerable sums of money. In terms of equipment alone, this related to a minimum annual cost of £300k from 2002 onwards.

From a manpower view point, this related to a one-off expense of £38k. On-going costs are 2 to 3 hours per week running the system and the VLE Manager's salary per annum. This is an ongoing cost with a minimum annual expense of £25k from 2004.

The restricted student access has meant that integrating ILT into the curriculum has not progressed in many areas as far as it should have done. This is still being addressed, and is improving. All teaching rooms are being fitted with SMARTboards, projectors and a PC, even if there is not a set of computers for students to use. This will enable staff to integrate ILT more effectively, and allow them to meet the requirements set out by OFSTED.

The MLE has not become fully integrated yet, and there is still a tremendous amount of work/expense needed to accomplish this. Once again, it was the finances that have held back the developments.

10.4.2 The Ease with which the Resources can be Used

The lessons in the mathematics resources were easily understood and laid out well. They were straightforward to find. The only problem with them was found during term 3, and this was that students who did not use the resource regularly found that the lack of being able to “fast forward” through a lesson was irritating.

The accessibility of the resources improved over the year. This was initially due to log-in problems in 04/05 and low connectivity off site because of the lack of broadband access in favour of dial up. The log-in problems were mainly for part time students who had enrolled late. System unreliability has a negative effect on student attitudes as reported by Reynolds et al (2003).

The majority of students had Blackboard demonstrated to them, so they found this the easier to use, because they had been shown. Others also used Moodle, as part of its trial, but they were not shown how to use it, and had to learn this for themselves. This made it less accessible at first. This reflects Forsyth (1998) and Frau et al (1992) who found that being shown how to use a tool made it easier to use than having to find out how to use it by trial and error.

10.4.3 Time Required for the Preparation of the Resources

On average it can take 6 hours to prepare a 2 hour session. This includes basic slides with no interaction, and a set of exercises only. The development of on-line materials by the teaching staff is ongoing. Where materials are in place, these are now being added to and improved. It can take up to 5 minutes to log in to the system and upload lesson materials.

There is a measurable minimum standard expected by the College for all VLE sites. This is linked directly to both staff appraisals and staff pay through the competency framework. As a consequence, staff who avoided using the VLE are no longer able to do so without financial repercussions. This senior management approach is a key factor to success which was found by Littlejohn (2003), and Nicole and Coen (2003).

10.4.4 Meeting the College ILT Strategy 2002/05

The part time students were more focussed and so they accessed the resources more in term 3. The use in this term was very selective, and individualistic. It was more about improving results rather than review/practice. This corresponded with the need to complete the unit with the best possible grades rather than taking exams.

10.5 The Learners' Experience

The learner's experience needed to look at different attributes, and was more about how the student's felt about the mathematics resources and the VLE platform.

10.5.1 The Usefulness of the Resource

The usefulness of the resources was viewed differently by the students in 04/05 and 05/06. In 04/05 the students expected reasonable detail and to be able to learn directly from the resources, rather than use it as a support mechanism; whereas the 05/06 cohort expected the resources to be a refresher, rather than starting from scratch. Consequently, the 04/50 cohort chose the resources as their third choice for support, whereas the 05/06 cohort chose it as their second choice. Both years chose individual tuition as their first choice, with using the internet in other ways being their last choice.

Those who used the resources, as opposed to just browsing through, found that they were useful to use again. Over 85% of users would recommend the resources to others. However, it was agreed that a basic understanding was needed first, so the resources were only suitable for support in their present form. As a means of support the main disadvantage was the lack of personal support if problems were encountered, but it was ideal as a second information source for notes. The ability to be able to spend as much time as necessary using them was seen as a major strength, in a similar way to the findings of Dahler (2009), and Rishi (2007) with regard to successful learning.

One of the problems with the resources was ICT related. This was to do with computer capability and internet accessibility. This related to the speed of accessing the resources, as well as the differences between using broadband or dial up. Reynolds et al (2003) found that this would have a negative effect on students. However, the resources were viewed as valuable because they were downloaded by several students. This would overcome any access difficulties when wanting to use them again.

The resources were considered to be good across all topic areas, with algebra and calculus being the most useful. This was because there were examples as well as statements of rules, so that it made it easier to follow the steps as well as to follow why each process happened. This also matched the problem areas found by Hobson and Rossiter (2010).

The use of the resources by the dyslexic students did not seem to be any different from the other students. They had extra strategies, which did not necessarily link to the VLE, to help them alongside of the resources, but they too were pro-active in their learning. The interface needs seemed to differ between individuals, so there should be an ability to alter this for individual use without altering the lesson contents.

Some students initially used the resources because of a recommendation by others, and also recommended the resources to others. This required the maturity to not be bothered that others knew that they were using the resources.

10.5.2 Why the Resources are Useful

The resources were regarded as being useful because they could be used as a refresher or recap at anytime, and anywhere with internet access. They were considered to be easy to understand as well as being a good source of extra information. Three quarters of the students using the resources found that they helped them to keep up with the mathematics work, and they were seen as a useful addition to the normal face to face lectures, similar to Abouserie et al (1992) in that they could support, but not replace face to face teaching. The VLE does give an option to pro-active students. If it were not there, it may be more difficult for them to get extra help.

The overall response from the users of the resources was that they were very useful and that the students were enthused about them. The lessons were not too complex, and were accessible even if the topic had not been met before. Students liked knowing what topic areas were used for in real life, which was a feature of the resources.

10.5.3 Whether the Resources Meet Individual Expectations

More than half of the users of the resources felt that no improvements were needed to the resources. They were easy to find and access, as well as being suitable to learn from. The layout was good and well labelled, and it was a user-friendly system, once IT Support had improved the log in system. This initial unreliability and other technical problems at the start of the year were seen as the major flaw for the resources.

The improvements that were cited were mainly more technically oriented – such as interaction, animation, partial reveal, automatic email, more links, voice over – and looking more like a professional web site resource, such as the BBC websites. There were mixed reactions to the suggested improvements, with several students wanting the facility to switch them off. Many students also asked for there to be more worked examples as well as extra exercises. In addition to this, several students felt that the provision of further support for basic mathematics topics needed in the main course would be helpful.

The general expectation was that the resources should have contained class lesson notes, further worked examples, materials for assignments and assessments, and enough information to be able to understand a topic if it had not been understood in class. This was all in place with the resources; however, several students felt that it needed to be more interactive for them to learn from it directly, matching Sullivan and Mousley (1996) and Asp and McCrae (1999) findings that to learn successfully it is necessary to interact and engage with the materials.

Individual students' comments are summarised in Table 10.1. This clearly shows that the resources met most students' expectations.

Benefits of the VLE resources	Reasons for non usefulness of VLE resources
Extra support Preview lessons Useful revision source Different explanations Can take own time Can go over what you want Can access when you want Easier to keep up Easier to catch up Good information Simpler to understand Extra resource Good refresher Help remember more easily Help understand more Practical, easy to use Complimentary to taught session Best possible support Very accessible Step by step guides Gave more confidence	Prefer individual tuition Only looked at the lessons because they were there Mathematics is easy to remember (qualified students who passed with distinction grade) Don't like mathematics so I can't study it on my own I like mathematics so I don't have any problems with it Can't provide answers to questions No help if you get stuck

Table 10.1: Individual Students' Comments Regards Experience of VLE Resources

The students who did not find the resources useful had other issues which impacted upon their needs. This also shows that there is a floor to the level you can learn from for the VLE resources.

10.5.4 Consideration of Attitude Changes

Many felt that the mathematics resources had helped them to succeed, and they had not only increased their mathematical ability, but also their confidence. Gaining a greater understanding through the applications of mathematics to real problems in their engineering discipline had also had a positive effect. In terms of attitude, only a few felt that this had improved, but none felt that it had got worse. This however, was more to do with the change from school to college than the resources.

However, there were some issues regarding the use of the VLE resources.

Several of the groups were expected to access the VLE regularly for all of their subjects and many of their assignments, and they claimed to have used them, but the computer logging evidence showed otherwise. Clearly to admit to not using the resources might be problematic if it was to be relayed to their course tutor. Also some students used the mathematics resources secretively. Their peer groups were openly non-users so they both had to use the resources as invisible support in order to achieve their own individual goals. Using the resources was a hidden way of getting support. It did not make their extra efforts obvious to their peers nor did it flag up their extra support.

Looking at all of the students, whether they used the resources or not, their individual mathematical ability ratings increased over the year, although they remained the same within their groups. They rated themselves more able than others of their own age, but they still slightly disliked mathematics overall. The improvement in attitude is not really acknowledged by the students and the improvement in ability is exaggerated by them.

The more use that was made of ICT by the students, the better their ability. This was building their confidence through practice, but was not mathematics specific in 04/05 whereas in 05/06 mathematics use of Excel and the VLE for other subjects made ICT much more useful. This helped to change attitudes positively to using computers rather than avoiding them, but they did not like using them any more than at the start.

Overall, the resources did have a minimal effect on attitudes and abilities with ICT. The improvements were due to their greater use of ICT in all subject areas. The decline in attitude was partly due to their reliance on using computers, and not always having the accessibility or reliability that was necessary. Also the requirement to use them in an intense work-related way rather than as a source of entertainment had an effect.

Some students seemed to have the attitude that they would pass at the end of the year, irrespective of what they did on the course. They had all come directly from schools where the work ethic was externally enforced and were not used to the College system whereby the work ethic was internalised through self discipline. They had not taken ownership of their own actions at this stage. The resources helped them to turn this around in their second year when they used the resources extensively. This more pro-active approach enabled them to pass at their second chance.

10.5.5 How this Meets the College Learner's Policy 2004

There is an expectation by the College that students will be pro-active in their learning. As only 2% would do nothing if they were having difficulties in mathematics, then this shows that the majority of students would be pro-active. Most students preferred to seek extra help from their lecturer, with other people (friends, other students, work colleagues) being their second choice. Twice as many preferred using books to searching the internet, although using the VLE mathematics resources were viewed as more akin to books than the internet, particularly as the information was transferable to other subject areas, such as key skills and science.

Part time students found that self study was easier than asking for help. This was due to their lack of accessibility to their lecturers. The use of the resources was dependent more upon the attitude of the students' course organisers. If they were not encouraged to the resources either by staff or their peers, they were less likely to access them in the first place, and would rely more on text books which they were more familiar with. The part time students were generally better qualified mathematically than the full time students, but they put more effort in over the year because they were concerned that they may not succeed. There was an expectation that mathematics would be difficult and so it would require extra work from the beginning.

The use of the mathematics resources increased over the year. This was partly due to staff encouragement to use VLE resources generally, but also to recommendations from other students who were finding it useful. The use of textbooks as a source of help declined, but they was still used when computer access was not possible.

In 05/06 the VLE was more accepted, and it was no longer seen as novel. The mathematics resources were available from the start, and the students were more aware of them. This cohort expected them to be there for extra support and help, and used them as such. However, some students also used them to prepare for future lessons, so used them to gain a basic understanding in advance of being taught.

There was a clear culture shift from 04/05, when the VLE (and the mathematics resources) were seen as additional work; to 05/06 when they were seen as additional support. This culture shift has continued since – partly due to new intakes every September, but also because staff and students have become more reliant on the VLE to host materials. It is now no longer seen as an extra, but as an integral part of any course, and of College life. From 09/10 it has become the expected norm for all courses and the students quickly complain if there is no provision for them.

10.6 College Policies

Under the section of College policies any improvements against benchmarks, and in figures generally, is considered.

10.6.1 Improved Retention, Achievement and Success

For the pre 02/03 standards the success was above benchmark, at good to outstanding. The part time provision was mainly grade 1 (outstanding) with the full time provision also at grade 1. These standards were dependent upon students having to pass all criteria, with merits and distinctions being dependent upon the synthesis and deeper understanding demonstrated. It was possible to be successful by being very good in some areas to compensate for weaker areas.

For the post 02/03 standards the success was well below benchmark, and only rising to satisfactory. The part time provision had dipped substantially until the introduction of the VLE resources, at which point it improved to good and has improved since. The full time provision also dipped substantially, but even after the introduction of the VLE resources it remained at an unsatisfactory level. The resources were not sufficient to improve retention rates, but they did help to improve the achievement rates. Use of the VLE resources had a positive impact on student success, and students who used the resources were more likely to succeed. Students using the VLE had a higher pass rate overall, compared to students not using the VLE. The VLE users clearly did better. Despite there being a greater availability of the VLE in 05/06, the impact was greater in 04/05. Nearly all the non-qualified students using the VLE passed whilst nearly all the non-qualified students not using the VLE did not pass. The only non qualified students to pass were those who used the VLE. This seemed to be down to several reasons. The most common reasons were an increase in confidence and having unlimited time to study the materials. The VLE resources enabled non qualified students to achieve success. Where there is specific teacher led support, this is preferred to using the VLE resources. The use of the VLE resources has clearly had a positive impact on part time student success, and particularly in the case of "non-qualified" students. Although the impact of the VLE was not as significant for the full time students in comparison with the part time students, it still clearly showed that the VLE users did better. The full time students also successfully engaged with the resources.

10.6.2 Improved Figures

The full time students' entry qualifications were reducing over time, which meant that they had less likelihood of success on the programmes. Both Telecommunications and Manufacturing were hampered by having to have viable numbers to run. There were major problems with the poor entry qualifications of the Telecommunications students, together with high drop out and referral rates. The Manufacturing students regularly left at the end of the first year. Although for the more able this was to take up apprenticeships, for others it was because they had become disaffected by the work required to succeed. As a direct consequence of this, neither of these courses are delivered any more. Instead, there is a single more successful general engineering course with a greater variety of units covered and more practical applications included.

The changes to the reporting of results meant that students had to remain on the course as well as passing at the end. The level of merit and distinctions was no longer important, but the overall number of passes (as opposed to fails) was a major concern. One consequence of this was that student support mechanisms, such as the VLE resources, became the norm rather than an optional extra. Also, as the subject became more applied, the greater the need for support – particularly with the lesser qualified full time students who had no relevant work experience to help them to relate the mathematics to the applications. Using the VLE resources helped non-qualified students to succeed. There was a direct link between use and success. There was also a positive impact on achieving higher grades. Using the VLE resources enabled non-qualified students to not only pass, but also to gain higher grades.

More students using the VLE achieved better than pass grades in both years, and using the resources clearly had a positive impact on full time students achieving higher grades. This was significant for full time students in both years; and for part time students in 04/05. The 05/06 results did not show much difference between users and non users for higher grades, particularly for qualified students. However, the resources had a significant positive impact on non qualified students' achievement of higher grades.

Students' attitudes also had an effect on their final success. The part time students were more pro-active in catching up work, even though it was more difficult for them because of work commitments and not being able to access lecturer explanations. Sullivan and Mousley (1996), Asp and McCrae (1999) also found that interaction enhanced learning. The Manufacturing students (full time) felt that it was easy to catch up, and often didn't bother. The

Telecommunications students (also full time) felt that it was hard to catch up because the level and amount of work per session was very intense. The Telecommunications students were the least well qualified of the entire student intake. In all the full time groups the attendance was poor throughout the year. These groups also had a false sense of the rigour of the internal tests, and did not expect them to be of the same standard as externally set tests. There was the false assumption that they would be easy to pass. This reflects the student motivation findings of Cook and Timmis (2002), who found that poor qualifications lead to lower motivation.

In term 1 many students accessing the mathematics resources for support did so because they lacked confidence. By term 3, this access depended much more on how much the students wanted to succeed. Initially using the resources and getting help was seen as cheating, but this changed, and both were just seen as different forms of support by the end of the year. As students became more successful with mathematics, they became more confident, and several began to like mathematics more. Those who continually struggled had a negative perception of the subject, which was difficult to change. This agrees with Parsons et al (2009) who found better qualified students had greater confidence.

Algebra and Integration were topic areas that most students required support in. This was also the case in Hobson and Rossiter's study of engineering students at local colleges (2010). Those with poor mathematics backgrounds needed extra help with transpositions, expressions and equations – particularly the full time students. The part time student accessed trigonometry and Pythagoras the most for their examinations, but the full time students had covered this recently at school, so felt that they did not need to. Once again, the individual topic areas reflect the findings from Hobson and Rossiter (2010). The full time students accessed Applied Problems more because the part time students had already used these concepts practically elsewhere. The better the entry qualifications of the students, the less the support that they required to achieve success.

10.7 Layering Effect

The study also intended to investigate the effect of layering the unit into criteria. Instead of working with a topic area to its full conclusion before moving on to another topic area, the layering system deals with a topic at basic level initially, then revisits it later in the course at a higher level, and so on. This meant looking at comprehension against recall, and attainment.

10.7.1 Comprehension versus Recall

The full time students had limited opportunities to apply the mathematics work to real situations, but used their knowledge in other subject areas. The part time students were able to apply their knowledge realistically within their work places, which helped understanding.

The second term's work was remembered mainly because of prior knowledge, but the third term's work was remembered by application and had more to do with individuals' attitudes and efforts, which related to different group's ethos. The part time students were more inclined to learn whilst the full time students tended to rely more on prior knowledge.

Many students disliked the mathematics more as it became more difficult. This difficulty was also reflected in the length of time that was required to learn a new topic before being able to apply it. Term 2 was substantially harder than term 1, and there was more rigorous testing of the new topic areas as well. The part time students needed more support because they wanted to be able to apply their knowledge in other units. They spent more time trying to understand rather than cramming for tests. As a consequence their comprehension was good. The full time students relied more on recall than comprehension, and this was reflected in their achievements, as they had difficulties in applying what they had learnt.

10.7.2 Final Attainment and Results

The final results for the mathematics unit were a true reflection of the students' abilities at the time. Many of the students felt that they had improved their mathematics after completing the unit, because it had been applied practically in other subject areas. This meant that they could have achieved better results with further study. However, the final attainment was not necessarily as they had expected when they started the course, it was frequently better.

There was a clear difference in the attitude towards mathematics between the full and part time students. The full time students only had experience of mathematics from school, and as a consequence, regarded it as unnecessary. This attitude did change during term 3, when there were more practical applications used. The part time students also preferred to have more support prior to tests, in order to pass first time, whereas the full time students preferred to have more support after the test if they needed to retake it. The higher grade work was used by the part time students in other subject areas, so they were keen to have support in these topics; whereas the full time students knew that they would be able to revisit these topics in their second year, so were not as interested in getting the support at this time.

10.8 College Results

The differences between the results prior and post the implementation of the mathematics resources on the VLE, as well as the differences between the pre and post 02/03 standards are considered in this next section.

10.8.1 Comparisons of Results Prior and Post VLE Resources

The mathematics resources made no difference to the overall pass rates of the full time students during the period of the study. This matches the findings of Stoloff (1995), West (1997), Susskind and Guerin (1999) and Hastings (2002) that using a VLE had little effect on full time student success. However, the resources did improve the overall pass rates of the part time students over the same period. Individual students who used the resources felt that they had improved their results and that without them they would not have done as well as they did.

However, if instead of looking at pass rates, the value added is considered, then the resources made a substantial difference to individual students. Prior to the resources the level of qualifications for all of the students was better than at the introduction of the resources. Although the full time students were considerably weaker than the part time students, there was a higher proportion who met the entry qualification standards. This meant that there was a higher percentage who should have achieved overall. This was not the case – there was little difference before and after.

If the students who accessed the resources are considered, then the part time achievements were double those expected and full time achievements were five times more in 04/05; whilst in 05/06 part time achievements were 10% more and full time achievements were 2½ times more. This corresponds to the students views of improving their results by using the resources. It also shows that it is the poorly qualified full time students who are adversely affecting the College's results, as it is their success rates which are reducing the overall results substantially. This is despite them being the smallest group in the yearly cohorts.

The common factor for the students who passed was their pro-active approach to support. The students who were the least pro-active did not achieve as highly as their prior qualifications would suggest. The availability of in class support helped all of the students to succeed, but the use of the resources allowed the students to understand and remember their mathematics more easily. It would seem as if they needed the interaction. Several of the unmotivated students seemed to have had the ability to achieve even though their qualifications did not reflect this. The VLE gave an option to pro-active students. If it were not there it may have been more difficult for them to get extra help. Students who did not pass frequently had other issues outside of the mathematics unit. Whilst they were unsuccessful with the mathematics, they were also unsuccessful with the course. Poor attendance was the main criteria for lack of success, resulting in withdrawal from the main course; together with job loss and degree places, but there is also the idea of a 'floor' to the use of the VLE for some students. Several students who did not use the resources would not accept that they needed to do anything about getting support in order to pass. This suggests the need to encourage these students to use the resources more openly.

10.8.2 Comparisons of Results Pre and Post 2002/03 Standards

For the pre 02/03 standards, the full time results were masked by the UAE students, who did not have the option of not passing their course or any of the units. The withdrawal and referral rates were about the same, with high pass levels. However, the full time results were inconsistent, with good part time results. When combined, the withdrawals and referrals were steady, but 5% greater than expected. Similarly, the pass, merit and distinction grades were consistent, but more merit and distinction grades would have been expected. Overall the part time students' results were good to outstanding, with the full time results being good to reasonable. The employers chose the level of course for their employees at this time, so there were many students who withdrew rather than being referred, but there were also more distinction grades. The full time pass rates were always lower than the part time pass rates, which reflect the differences in entry qualifications between the full and part time students at enrolment.

For the post 02/03 standards, the full time results were less successful. This was due to two factors – firstly that the UAE students were no longer attending so their results could not mask any student lack of success – and secondly that the students were frequently enrolled to create viable class sizes rather than because of their qualifications. As a direct consequence the number of passes dipped, and the number of withdrawals and referrals increased substantially. The part time students, however, were showing a different picture. The number of their withdrawals was dropping, referrals were steadying, passes were improving and there were more passing with higher grades. This was due to using the layered method for teaching the mathematics, using the VLE mathematics resources and also being supported by the employers by enrolling students more appropriately by qualification levels. The full time results were poor, with the part time results good to reasonable. When combined, the part time results have carried the full time results, with the overall results being reasonable.

10.9 Evaluation of VLE Systems

The next section needs to evaluate the VLE system. This can best be done by using Laurillard's definitions of media and her "Twelve Statements" as a check list, as described earlier in Chapter 2. This will need to look at what it should cover, what it presently covers and what it is likely to cover in the future with further development work. This is illustrated in Table 10.2.

Narrative media was considered to be linear and non-interactive. The original mathematics resources were made in this way, so they met statements 1, 4, 6 and 7. Any future resources would also meet these statements.

Interactive media was considered to be linear media delivered in an open, user-controlled environment. The VLE met this requirement as it is a web based hosting platform. This meant that statements 6, 7, 8 and 9 were also met. Any future resource would also meet these statements.

	Statement	Media Type				Progress			
		Narrative	Interactive	Communicative	Adaptive	Mathematics Resources 04/05 & 05/06	Mathematics Resources post 2010	VLE 04/05 & 05/06	VLE post 2010
1	Teacher can describe conception	√		√		Yes	Yes	Yes	Yes
2	Student can describe conception			√			Yes	Yes	Yes
3	Teacher can redescribe in light of student's conception or action			√			Yes	Yes	Yes
4	Student can redescribe in light of teacher's conception or action	√		√		Yes	Yes	Yes	Yes
5	Teacher can adapt task goal in light of student's description or action				√		Yes		Yes
6	Teacher can set task goal	√	√	√		Yes	Yes	Yes	Yes
7	Student can act to achieve task goal	√	√	√		Yes	Yes	Yes	Yes
8	Teacher can set up world to give intrinsic feedback on actions		√				Yes	Yes	Yes
9	Student can modify action in light of feedback on action		√				Yes	Yes	Yes
10	Student can adapt actions in light of teacher's description of or student's redescription				√		Yes		Yes
11	Student can reflect on interaction to modify redescription				√		Yes		Yes
12	Teacher can reflect on student's action to modify redescription				√		Yes		Yes

Table 10.2: Media Types and Twelve Statements Check

Communicative media can be synchronous (same time) or asynchronous (different time) communication. The VLE platform allows e-mails (asynchronous), forums (both) and chat-lines (both). This is up to the course organiser to decide whether this communication is acceptable or not. This meant that statements 1, 2, 3, 4, 6 and 7 could also be met. Once again, any future resources would also be able to meet these statements.

The original concept was that the mathematics resources would be able to meet statements 1, 2, 3, 4, 6, 7, 8 and 9 from the outset. This has proved to be fully met, and the resources have matched the initial expectations.

Looking to the future provisions, there is a need to be able to embrace the adaptive media as well. This is when the computer responds to inputs by giving feedback. The VLE platform has the capacity to do this as well, but this was not fully utilised in the 04/05, 05/06 study. Progress is being made with this during 09/10 in terms of quizzes, activities, revision, assignment and assessment tasks. Post 2010, this will be the next expected standard to progress learning, and is already beginning to form part of the teaching and learning observation criteria. The VLE also enables the hosting of external and media links to simulations and educational games sites. By including this as well, the resources could also meet statements 5, 10, 11 and 12 through the VLE platform.

10.10 Evaluation of Overall Aim of Research

The overarching question was whether the use of a VLE enhances students' learning of mathematics. Within that, there were several under-pinning questions and themes which were explored in detail. Each of these forms part of this evaluation, and are looked at separately.

10.10.1 Resources Usage

Section 10.3 covered a wide variety of areas and questions. In terms of the use of the resources, they were not used by all students, but the majority of those who did use them not only used them again, but also recommended them to others. Hubbard (2007) found that the time and effort needed to produce resources was wasted on many students because they only used the lecture materials and did not use the online materials at all, which corresponds with these findings that many of the students did not use the resources. All topic areas were accessed, and the resources were used frequently with varying amounts of time being spent on them. There was evidence that they were used for support. The use of the VLE to host the resources allowed the students to access the materials at any time from anywhere with an internet connection, which they did. This reflects Timmis et al (2004) who found this to be the main benefit of a VLE. This demonstrates that the resources were used, and that students were pro-active in their studying. The greater use by part time students reflects the need for the ILT Strategy and the Learner Policy. Without these, there would not have been a resource like this to help them. The VLE clearly enhanced the students learning of mathematics if they were sufficiently pro-active to use it. The more interactively the resources were used the greater the benefits that the students received in terms of success.

10.10.2 Resources Viability

In terms of viability, the VLE was expensive to set up initially, but the running costs are not prohibitive. The usability has improved over the period of the study. In terms of materials preparation time, this has been the major downside. For staff who teach mainstream school based qualifications, the resources available for them to download and link to are extensive, but for pure vocational qualifications, the resources are very limited, and frequently do not meet the qualification specifications. For these staff to prepare materials from scratch is very time consuming, and further interactive options are becoming expected as part of the norm. The VLE is clearly viable financially and is being driven by the College to meet set minimum standards.

10.10.3 Learners' Experience

The learner's experience of the VLE system and the resources was generally very positive. The students saw them as valuable as several of them downloaded the materials for easier access. The students that had made use of the system frequently were very enthusiastic about it in terms of what it offered and how accessible it was. This reflects the findings of Weerasinghe et al (2008), Waldock (2008), Lupo and Erlich (2001) and Motiwalla and Tellos (2000) that the more use made of the materials, the more positive their influence becomes. There was a need to include further supportive materials covering underpinning basic mathematics for some students. The only drawback was that they did not feel that it was possible to learn from it directly, and that they still needed the lecturer to go through things and teach them. This corresponds to the concept of a floor to learning levels and to the findings of Hubbard (2007) that tutor interaction is a key factor. As the resources had been made to be a support and not an e-learning course, this was not unexpected. The students' first choice was always to have a lecturer, but the resources were seen as a useful back up tool. They frequently stated that using the resources had made them more confident. This is similar to the findings of Waldock (2008) that self study improves confidence. This evidence once again shows that the VLE resources did enhance the students learning of mathematics.

10.10.4 Success

Although the overall success of the students did not improve markedly during this study, there were a high proportion of students who should never have succeeded with the qualification, based upon their incoming levels of mathematics as evidenced through their entry qualifications. Using the VLE resources meant that the students were more likely to succeed, and this was particularly true for non-qualified students. This reflects the findings of Weerasinghe et al (2008), Waldock (2008), Hastings (2002), Susskind and Guerin (1999), Cavanaugh (1999), West (1997) and Stoloff (1995) that interactively using appropriate resources improves individual success levels, and suggests the need to encourage VLE resource use. The ability to study for as long as they liked was a factor in this. Students were able to prepare for lessons and be more confident because of their studies. The students felt that they had greatly improved in their mathematical ability, but that their attitudes had only improved slightly. Using the VLE resources allowed non-qualified students to achieve high grades as well as passes. The level of higher grades achieved was significant. This was due to several reasons – change from school to college, the helpfulness of the lecturer and the VLE resources. The VLE resources enhanced the learning, and hence the success of many students.

10.10.5 Layering

The layering of the mathematics did help to increase the comprehension of the topics for those that studied the applied problems and higher grade work. For the students who did not achieve beyond pass level, this allowed them to concentrate on passing rather than struggling with the more difficult concepts. Whilst their peers were working on the more complex mathematics, they were able to revisit the previous work and consolidate this. This meant the learning was able to be more specifically individualised, rather than the usual graded extension opportunities based on the lesson topic theme. Once again, the use of the VLE system and the mathematics resources enhanced student learning.

10.10.6 Conversational Framework

From section 10.9, it can be seen that the use of the VLE with the mathematics resources has transformed them from being narrative to both interactive and communicative, with the potential to become adaptive from 2010. This was an enhancement to student learning, even before the possibility of becoming adaptive, and fits with Laurillard (2002) and Kenny (2010) as to how resources can be aligned to media developments to aid student success.

10.10.7 Overall View

Having summarised each of the different areas, it is clear that the use of the VLE system has enhanced the learning for the students who have used the resources on a regular basis. Having said that, it is also clear that there is still a lot more that could be done to make them better for future students by harnessing more of the capabilities of the VLE platform. From a results viewpoint, there has been a significant difference in achievement for individual students who had the VLE mathematics resources as an extra support system. This is sufficient justification for both the College and the various regulatory bodies for it to be in place.

10.11 Summary

This chapter draws together the most important results and the consequences arising from these. The results were linked back to the original research questions, but the limitations and any reservations were also discussed in detail. The aims of the overall research question were summed up by the evaluation of the data, the VLE platform and the mathematics resources.

CHAPTER 11

RECOMMENDATIONS AND FURTHER RESEARCH

11.1 Introduction

This chapter looks at the further progress with the VLE since the start of the study and provides a variety of recommendations for the provision of learning resources, based upon the findings from the study. After this, possible ways ahead for following up the research undertaken to date are discussed. Initially this looks at the third area of investigation, “Engineering First, Mathematics Second”, which was suggested at the start of the research, but never followed up. It then goes on to discuss other possible options that have naturally arisen out of the data, and concludes with other ideas that are related to this study, but do not necessarily follow on from it directly.

11.2 Further Progress

Looking at the 07/08 and 08/09 statistics from the Moodle site, analysed via Google Analytical, shows how far the VLE resources have moved on since the start of this study. Figure 11.1 shows that the use of the Moodle site increased during the second year. This reflected what happened to Blackboard in 04/05 and 05/06.

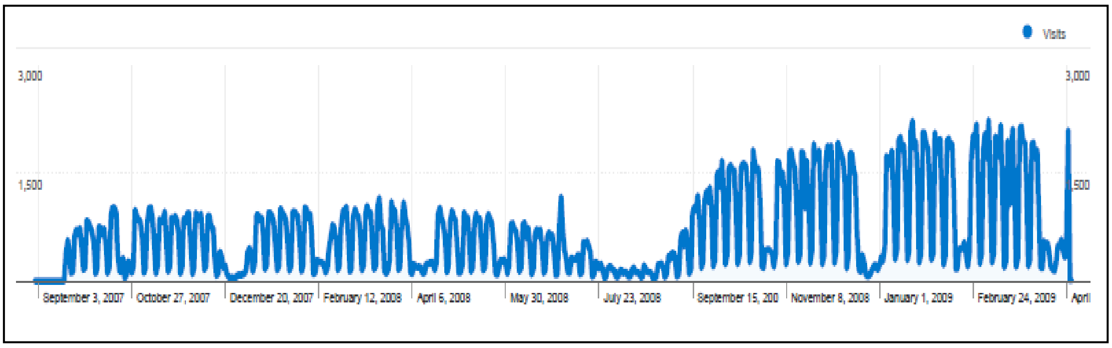

Figure 11.1: Site Usage 07/08 and 08/09

During this time there were 398,796 site visits and 2,382,948 page views. This relates to an average time of 4¼ minutes on the site and an average viewing of 5.98 pages per visit. In this time, not all the visits were directly from the college. This can be seen from the traffic sources data in Figure 11.2. This also reflects the split of access points from 04/05 and 05/06.

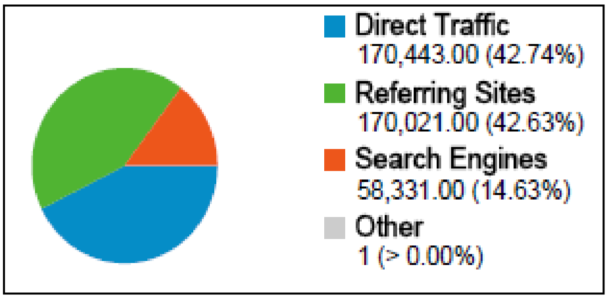

Figure 11.2: Traffic Sources 07/08 and 08/09

There were a variety of browsers used, but the most popular was Firefox, which was used twice as much as Internet Explorer. This is the preferred browser choice for the College as there are less security problems with it. The change to the connection speed has made a difference as there are less than 15% using any of the options other than Broadband, see Table 11.1.

Browser	Visits	% visits	Connection Speed	Visits	% visits
Firefox	266,571	66.84%	T1	257,118	64.47%
Internet Explorer	127,424	31.95%	DSL	58,750	14.73%
Safari	3,185	0.80%	Cable	55,622	13.95%
Chrome	931	0.23%	Unknown	22,753	5.71%
Opera	498	0.12%	OC3	2,600	0.65%

Table 11.1: Technical Profile 07/08 and 08/09

This matches with the findings of Dahler (2009), Rishi (2007) and Reynolds et al (2003) who found that the accessibility of the platform impacts upon its frequency of use.

The access from anywhere at any time is also clear. The visits from each of the different countries can be seen in Table 11.2.

Country/Territory	Visits	Pages/Visit	Avg. Time on Site
United Kingdom	397,321	5.98	00:04:16
United States	292	6.65	00:03:16
China	238	4.87	00:04:52
Germany	150	7.95	00:05:24
(not set)	116	4.34	00:03:22
Spain	71	4.28	00:01:57
Ireland	67	6.49	00:03:51
Poland	57	2.98	00:00:59
Turkey	48	5.02	00:02:45
France	47	3.23	00:02:20

Table 11.2: Access by Country 07/08 and 08/09

This shows that the VLE resources, including the mathematics resources, can now be viewed from anywhere in the world, at any time by staff and enrolled students – and staff and students do access a variety of the resources on the VLE. This matches with the findings of Dahler (2009), Rishi (2007) and Timmis et al (2004) who found that the anytime anywhere access increased the potential use by students.

If the key features of a VLE are also revisited, using Laurillard's (2002) features and checklist ideas, the present situation can be summed up by Table 11.3. Using a RAG rating clearly shows the progress to date.

	Feature	Description	Present Situation
1	Noticeboard	Managed daily, updates, topical events	Yes
2	Course outline	Outline, schedule, critical dates, hyperlinks, home page to modules and content of course	Yes
3	Student's personal pages	Profile page visible to all users	Yes
4	Narrative media	Print and video also available by hard copy on request	Yes
5	Adaptive media	Hyperlink to taster and full downloads, also DVD/CG if too large to download because of modem speeds	Not usually
6	Web resources	Reading list from web – resources, etc., - staff, library	Yes
7	Conferencing tools	Collaborative exchange (asynchronous) Small groups (synchronous)	No Discussion No threads
8	Assessment formats	Diagnostic pre tests with interactive computer marking – multichoice, open ended, model interaction, simulation	In progress
9	Assignment handling	Automatic upload for students and marking/feedback from tutor. Marks recorded for student on system	Some courses
10	Student notebook	Stored web page address linking materials and student work pages	No
11	Student contributions	Uploading of students materials by students into shared area	Tutor upload only
12	Bookmarking	Individuals can build up own list of favourites	No
13	Email	Email to tutors, peers and others in the organisation	Yes
14	Students home page	Progress page with all vital information and links to resources and institutional help centres	Some courses
15	Navigation	Course homepage default – easy hierarchical structure	Yes
16	Metadata	Author, date, copyright, audience	Some courses
17	Tutor support	Student progress and set targets. FAQ section. Monitoring access tool	Some courses
18	Student support	Generic information for IAG cross college	Yes

Table 11.3: Update on VLE Key Features

Overall, the use of the VLE systems does enhance the student learning experience generally, as well as within mathematics. This finding agrees with earlier results from Thompson (2009) who also found that the use of VLE systems enhances student learning experiences, although the research was not specifically linked to mathematics.

11.3 Recommendations

There are several recommendations that have come from this study. Just because there is a resource available does not mean that students will automatically use it – even if they are directed to do so. There is, however, a very strong case for having the resources available to support part time students. The resources need to be an integral part of the course and it's delivery so that there is no "optional" use of the VLE resources, instead it becomes a necessity in order to complete the course. The resources need to be interactive so that students have to engage with them rather than just read through them or make notes from them. By including assignments, simulations, and assessment work within these resources so that submission and results are also handled via the VLE the concept of any optionality is totally removed, and students are openly encouraged to use the VLE and its resources, without any form of stigma in using them.

As a “paper-saving” exercise, the resources do not really work. The students still receive hand outs and take notes during lectures – the resources are an extra to this. However, it is up to the students to consider whether they wish to then print this information out for themselves, or download the resources to view elsewhere. It does save paper in terms of staff only issuing one handout and then referring students to the Moodle site if they lose the original or miss the lesson, but it does not make for “paperless” study.

The use of the resources is very much by self selection, and for those who do self select it is a very viable tool. The pattern of use reflects the work in college, and the term times. It also builds a case for having open access library times rather than the present 9.00 – 6.00 opening times, as many of the students seem to be almost nocturnal in their use of the resources. Those who do use the resources tend to pass more frequently than those who don’t use the resources.

In terms of the resources themselves, there is a clear indication that interactivity is a key feature that should be developed. The students want to be able to work with the resources rather than passively look at them. They want the resources to be able to meet their individual needs, so that they can follow their own pathways through a topic that they find difficult. This means providing alternative pathways and hyper-linking within the materials. There is also the need to be able to start anywhere within a particular lesson's resource so that students do not have to keep going back to the start and clicking through to where they need to be. This can easily be done by adding in some hyperlinks within the slides to make this backwards/forwards navigation more accessible. Adding in voice over's and line by line delivery is also useful, as well as partial reveals – but these are features that need to have a "switch off" option as this does not suit all learners. Animation in terms of physically re-arranging equations in a visual form is also a feature that needs to be included. This is not animation for its own sake, it paints a visual picture of what is happening and students can follow more easily from line to line. They also want to be able to connect to other students and staff so the use of conferencing tools and emails are features that need to be available, with the caveat that misuse will result in sanctions for the student involved, with the possible removal of these options.

From a disability view point, all materials have to be SENDA compliant, and care needs to be taken with regards to colour schemes, font style, size of text, and the amount of information per page/slide. These are summarised in an article by Tyrrell (2007), who suggests shortening PowerPoint slides from the default size of 19.05 cm to 15 cm and only having 7 lines of text. In terms of font she recommends Arial, Verdanna or Comic Sans, with a size of at least 28 pt, but ideally 30 pt plus. Space needs to be used pro-actively to make items stand out, and call-outs or text boxes used to draw attention to items. She also recommends using the PowerPoint animations rather than Flash as they are more accessible for all students, and to use commentary for audio-learners.

This reflects the findings within this study from the feedback of the learner's who were interviewed.

In addition to the main resources there is also a need for additional worked examples and to have extra exercises available. All the topics should include applied concepts so that the theory makes more sense and is reached through a layered approach. This should also include links and references for alternative and additional study forms. There should also be further supportive material which covers basic topics which are not taught, but underpin the main course.

The resources need to be easily accessible with clear labelling and menu systems. They need to be easy to navigate through and the systems supporting them need to be reliable, user-friendly with fast download speeds.

Alongside of this, staff need to encourage the use of the resources by introducing them to students at the start of the courses and actively making use of them with the students throughout the course. To fully harness the potential of the resources to improve results, there needs to be more than just encouragement, however. The use of the resources has to be an integral part of the course, not an extra. This will help to combat any potentially negative peer pressure of using the supportive elements of the resources. In addition to this it has to be used as a compulsory intervention measure for students who are falling behind or struggling with aspects of the course. The intervention has to be linked to both the level of use of the resources and followed up so that students interactively engage with the resources rather than just look at them. This will further help non-qualified students to achieve better grades overall.

Taking the findings outside of the specific research context there are elements which would be of use to the wider community. Clearly the advice of Tyrrell (2007) is a key point to follow when preparing resources. Further to this the resources need to be an integral part of the main course so that use of them is an expectation rather than being optional. Use of individual parts of the resources also need to be set as both targets and intervention tasks to encourage both catch up and interactive engagement. This interactive engagement also needs to be followed up by assessment of the work, preferably by on-line assessment linked from the resources.

If the recommendations are taken outside the context of this specific research and into the wider community, then there are several elements that are valuable within this context too. Both part time and poorly qualified students are more likely to succeed if they have a VLE resource to use. In order to capitalise on the effectiveness of VLE resources it is important to have the resources as an integral part of the delivery and work schedule so that there is no element of negativity attached to the use of the resources. The logging of the use by individual students needs to be checked by tutors so that the reality of use can be verified and acted upon accordingly. The resources must be shown to the students from the start and then used interactively as part of the induction processes. The resources need to be referred to regularly so that they cannot be “forgotten”. There has to be a culture shift so that all staff use and support the use of the VLE throughout the course. The IT systems must be fully operational and accessible to all students and staff with minimal downtime. To be fully effective the VLE has to become the heart of the course with everything else built around this major resource.

11.4 Further Research

Although the study has covered what it set out to investigate, there were areas that could not be researched within the given time frame. There were also questions that arose from the research, which could form further in-depth studies in their own right. Along with this were possible parallel studies whereby the research was repeated in different ways. These areas and studies are briefly detailed in the following sections.

11.4.1 Engineering First, Mathematics Second

When the possible research questions were first outlined, the third factor, "Engineering First, Mathematics Second", was mentioned, and the first option for further research would be to take this concept and investigate this in depth. In order to do this it would be essential to integrate the mathematics more fully into the engineering concepts. This can be done by adding in linking theory, using cross referencing techniques between the other units and having more interactive engineering work linking back to the mathematical theory. This would be a much larger task as it is dependent upon specialist engineering staff helping to build and add to the resources, although this has already begun during the life of this case study within some of the engineering disciplines, it would need to be extended. The course teams would need to be fully involved so that all engineering disciplines are fully integrated. To develop the unit to this level would take a lot of time and effort from the staff involved. It is almost a complete restructuring of the way the syllabus is delivered and as such is a large step to take.

Once the resources were in place a replication of the present study could be undertaken. This would provide a comparison between the present system and the fully integrated system. There would need to be additional questions answered as well. Not only would the study need to compare, it would also need to look at the new emphasis and the changes that this might bring about and issues that it would raise. By making the mathematics appear to be more dependent upon the engineering topics, does it increase its importance or value to the students? Does the use of interactive elements make the students more receptive to using ICT? What is the effect on attitudes, ability and enjoyment of the subject area? Does the application mean that the theory is retained more and applied more easily? Is there a knock-on effect to lower drop out and referral rates? Do more students actively choose to take engineering courses at the College because of the different style of study?

This further study is a valuable way forward, but the preparation involved is extensive. It may be more feasible to tackle each engineering specialism as a separate task, building the units together and then going back and revisiting the whole process again with each different specialism.

11.4.2 Questions Arising from Study

Another option would be to look at the areas that have provided a different or unexpected view of the data. The idea of “active/passive learners” and their support mechanisms, particularly in terms of their use of the VLE, was something that came out of this study. The study indicated that the students labelled as “active learners” make use of all sorts of resources, but that those who were labelled as “passive learners” seemed to want everything spoon fed to them. If this is a true reflection of these types of learners – something that would also have to be proven – what support mechanisms will engage them? How can passive learners be encouraged to become more active? How can the VLE be adapted to suit their requirements whilst still providing for the needs of other students? How does the concept of “active/passive” fit with the myriad of other learning styles already catalogued by a range of psychologists and educational theorists? Do they have different strategies in other subject areas? Are engineering students more likely to belong to one style than the other? Does it relate in any way to the areas of the brain that are being used for the subject area? Is it true for other nationalities?

Although this area is one of great fascination, because of some of the biological and psychological implications, it would need to involve several specialist researchers to follow their line of questioning, and a joint effort of combining all of the information. There is also a concern that it may not provide anything new and only confirm theories already in existence. As a consequence, if this line of research is taken, it will have to be very carefully planned out to get the optimum data.

11.4.3 Other Related Research Options

Other options that have arisen whilst undertaking this study which relate directly to the VLE or mathematics can also be considered. One option could be to catalogue all the mathematics resources that are freely available and rate them according to their accuracy, user friendliness, appropriateness and students' experiences of using them. During this study it was noticeable that the majority of commercial resources were school based for GCSE, A levels, and the Key Stages of the National Curriculum. Whilst the vocational qualifications do have commercial resources, they frequently do not provide on-line resources for the mathematics units. This means that it is always a case of a “best fit” scenario when using commercial resources. At the same time, to produce these resources personally is beyond the time scale and often the expertise of the individual lecturers. By researching more fully into what the students find best it would be possible to improve the offering to them. At the same time this could be linked in to the VLE. Which is the best VLE and why? What is the best layout for a site? How should the materials be presented? What facilities are needed? How can it be optimised to incorporate real time delivery?

Another option would be to revisit this case study with a different set of students. That way it would be possible to do one of several things:

1: Compare present with past

2: Compare mathematics within engineering against mathematics within a different area

3: Compare nationally

4: Compare internationally

A further option would be to look more deeply into the use of VLEs in terms of more mobile devices and applications. At the moment, it is necessary for students to have access to a computer and internet access (preferably broadband). With the emerging technologies, it is now possible to use mobile phones and mini computers, which are hand held devices and very portable. Samuels (2007) found that students were more interested in using portable items. The screens and images are very small, but there is the potential to utilise these more, as they become more accessible to students. This could be through the form of multi applications, as with the iPhone route, or through a different form of use from the present wireless/Bluetooth options. With this new technology, there is likely to be a different form of involvement, as per the social networks, and this different style of interaction needs to be exploited to make learning more enjoyable for the digital natives. Research into this area is unlimited as it would be looking to the future rather than seeing what has already happened.

11.5 Summary

Overall the research has shown the following:

- Using the resources interactively produced the best improvements
- VLE users were more likely to succeed than non-users
- Non-qualified part time students success rates improved with use of the VLE resources
- Full time students achieved higher grades through VLE resource use
- Non-qualified students achieved higher grades by using the VLE resources
- Regular use of the resources improves students' confidence in mathematics
- The resources were a useful additional support, especially for part time students
- The resources were valuable enough to be downloaded by several students
- The resources provided pro-active students with extra help that they might have found more difficult to obtain
- Application of theory based on layered learning makes it easier to comprehend
- Extra materials covering underpinning mathematics topics are needed to support anticipated deficiencies
- There is a floor to the level that can be learned from the VLE

- Access 24/7 is needed for all students
- Staff attitudes influence students use
- Students need to be encouraged to use the resources to greatly improve their chances of success
- SMT leadership drives successful improvements
- Resources are used when convenient and comfortable for students
- Resource access is more frequent for assessment work
- Algebra, trigonometry and calculus are difficult areas requiring further support
- Conferencing facilities are needed to add in 1 to 1 support
- Student achievement increased, especially using value added criteria
- Part time students wanted to apply knowledge whereas full time students preferred to recall information
- Pro-active students enhanced their mathematics studies by using the resources regularly
- Layering increased comprehension of higher grade and applied work
- Use of the resources enabled a greater ability to individualise learning for students
- Use of the resources enhanced mathematics learning
- Resources are labour intensive to produce from scratch
- Plug-ins to the VLE allow expansions of the services whilst keeping control of progressions
- Open source systems are preferable to proprietary systems because of ongoing costs

In terms of the chapter, the progress to date of the VLE platform and its present usage were considered and after this several recommendations were given regards designing resources for others based upon this study and continued with possible ways ahead for following up the present research. This was by considering the original third area of investigation, “Engineering First, Mathematics Second”; options that had arisen from undertaking the present study; and other related options that did not necessarily link directly back to the study. A brief outline of the various concepts and what they would involve in terms of preparation, together with the possible questions that could be considered for each of these options were discussed. A brief set of the main findings was also included within this summary.

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APPENDICES

Mathematics for Engineering

Module Number 14166H

Level N

Module Value 1.0

Rationale

The definition and solution of engineering problems relies on the ability to represent systems and their behaviour in mathematical terms, which in turn depends on the use of various mathematical .tools. This module deals with those mathematical skills and concepts relevant to effective performance in engineering employment at technician level.

Aims

The aims of the module are to enable the learner to:

- model simple engineering systems;
- generate numerical values for system parameters;
- manipulate data to determine system response in defined
- conditions;
- evaluate the effects on systems of changes in variables;
- communicate ideas mathematically.

Outcome	Performance Criteria	Range	Examples/Applications
1 Make use of appropriate (electronic) aids to calculation	1 Appropriate tool selected 2 Calculations performed correctly using appropriate facility	Scientific calculator Spreadsheet Computer algebra package Statistics package Arithmetic functions Trigonometric functions Logarithmic functions Exponential functions Statistics Curve fitting	Presentation of laboratory results in spreadsheet form Manipulation of experimental data Simple project costings
2 Obtain reasonable answers to engineering problems	1 Answers obtained by appropriate method 2 Answers evaluated with respect to orders of magnitude, dimension 3 Answers expressed to degree of accuracy commensurate with application 4 Answers checked for validity and accuracy by estimation techniques	Numerical solution of engineering problems Significant figures Decimal places Indices Percentages Preferred units SI/Imperial systems as appropriate	Conversions eg m → km → mm Preferred units eg KN, GW, mV, pF, °F, psi

Outcome	Performance Criteria	Range	Examples/Applications
3 Use tables and charts in the solution of problems	1 Relevant reliable information extracted from tables 2 Relevant reliable information extracted from charts	Conversions Production schedules Timetables Part sizes Statistical tables Manuals Graphs Nomograms Gantt charts Pie charts Histograms Bar graphs	Most appropriate standard size such as SWG B.A threads Cable sizes Component data and performance characteristics Calibration curves Quality Control Production data Defect statistics
4 Perform calculations in various number systems	1 Calculations performed accurately within the appropriate number system 2 Calculations performed accurately within the appropriate measurement system	Binary Octal Hexadecimal SI Imperial	Switches Logic gates Karnaugh map Imperial equivalents of thread/rivet sizes
5 Solve problems using given formulas	1 Appropriate formula selected 2 Correct answers obtained by numerical substitution	Appropriate to the relevant branch of engineering Direct substitution	Newton's 2nd Law Ohm's Law Area etc Gas laws AC circuits Impedance, reactance, frequency

Outcome	Performance Criteria	Range	Examples/Applications
6 Solve problems expressed algebraically	1 Appropriate formula selected	Change of subject	Strain gauge readings Electrical circuits Linear motion Reactance Material removal
	2 Algebraic manipulation carried out correctly	Linear equations Quadratic equations Simultaneous equations	
7 Use graphical methods to evaluate data	1 Appropriate coordinates selected	Cartesian Polar	AC systems Loadlines Slope resistance Simple harmonic motion DC transients F = ma Kinetic energy Data from experiments
	2 Appropriate scales selected		
	3 Data plotted accurately	Manually Electronically Using software	
	4 Graphical representations interpreted	Linear graphs Exponential graphs Logarithmic graphs Polynomial graphs Sinusoidal waveforms Square waveforms Sawtooth waveforms	
	5 Final relationships identified		

Outcome	Performance Criteria	Range	Examples/Applications
8 Use calculus for engineering problems	1 Simple expressions differentiated correctly 2 Simple expressions integrated correctly	Algebraic functions Trigonometric functions Rates of change Maxima and minima Look-up tables Areas Look-up tables	Induced emf Transformer Velocity Acceleration Instantaneous values Optimisation of variables in mensuration applications Small changes – expansion and contraction Maximum efficiency Maximum power transfer
9 Use numerical methods for integration	1 Appropriate numerical values determined	Trapezoidal Mid-ordinate Software methods	p-v diagrams s-t relationships Work done Volumes and areas
10 Use trigonometric relationships in engineering contexts	1 2D shapes correctly represented 2 Appropriate numerical solutions obtained	Trig ratios for right angled triangles Trig ratios in solution of general forms of triangles Use of radian forms	CNC programming Friction on an inclined plane Frameworks Power diagrams Phasor diagrams Rotational problems AC networks

Outcome	Performance Criteria	Range	Examples/Applications
11 Evaluate physical properties in given situations	1 Areas calculated using standard shapes and formulae 2 Volumes calculated using standard shapes and formulae 3 Mass calculated	2D 3D Regular bodies Composite regular bodies	Sheet metal work Estimates of mass, quantities, loadings
12 Use basic statistical concepts to handle data involving no more than two variables	1 Data presented effectively 2 Mean and standard deviation calculated using appropriate aids to calculation 3 Results interpreted	Manually Computer packages Scatter diagrams Median Mode Test data Experimental data	Quality Control Reliability Defect analysis
13 Represent physical quantities as vectors	1 Vectors represented correctly 2 Vector quantities manipulated correctly	Addition Subtraction	Force & velocity diagrams Velocities
14 Use complex numbers to model engineering systems	1 Complex numbers represented correctly 2 Complex numbers manipulated correctly	Argand diagrams Addition and subtraction of vertical and horizontal components	Transmission lines Circuit modelling Phasors

Unit: Mathematics for Technicians

Learning hours: 60

NQF level 3: BTEC National

Description of unit

This unit has been designed to provide a foundation in mathematical principles, which will enable learners to solve mathematical, scientific and associated engineering problems at technician level. The unit has also been designed to act as the necessary prerequisite for entry to Higher National Engineering programmes and to provide the mathematical base for the *Further Mathematics for Technicians* unit within the programme.

This unit presents opportunities to demonstrate key skills in application of number, information technology and problem solving.

This is an internally assessed unit.

Summary of learning outcomes

To achieve this unit a learner must:

1. Determine the fundamental **algebraic laws** and apply **algebraic manipulation techniques** to the solution of problems involving algebraic functions, formulae and graphs
2. Use **trigonometric ratios, trigonometric techniques and graphical methods** to solve simple problems involving areas, volumes and sinusoidal functions
3. Use **statistical methods** to gather, manipulate and display scientific and engineering data
4. Use the elementary rules of **calculus arithmetic** to solve problems that involve **differentiation and integration** of simple algebraic and trigonometric functions.

Content

1 **Algebraic laws and algebraic manipulation techniques**

Algebraic laws and manipulation: introduction to algebraic expressions and equations, algebraic operations, rules for manipulation and transposition of formulae; manipulation and algebraic solution of algebraic expressions; direct and inverse proportion and constants of proportionality; linear, simultaneous and quadratic equations; graphical solution of simple equations; use of standard formulae to solve surface areas and volumes of regular solids; use of calculator for algebraic problems

Indices, logarithms and functions: the index as a power, numerical and literal numbers in index form, laws of indices and logarithms, common and Naperian logarithms, functional notation and manipulation, logarithmic and exponential functions, other simple algebraic functions

2 **Trigonometric ratios, trigonometric techniques and graphical methods**

Trigonometric ratios and techniques: basic trigonometric ratios – sine, cosine, tangent, solution of triangles, the circle, radian and radian measure; use of calculator for trigonometric problems

Trigonometric functions: nature of oscillatory functions; graphs of sinusoidal functions and the graphical determination of periodic times, frequency and amplitude

3 **Statistical methods**

Data manipulation: gathering and collation of data from varying sources; grouped and non-grouped data, frequency; graphical representation of statistical data, using bar charts, pie-charts and histograms

Statistical measurement: measures of central tendency from group data – mean, median, mode, standard deviation and variance; use of calculator to manipulate statistical functions

4 **Calculus arithmetic, differentiation and integration**

Differentiation: introduction to the differential coefficient, graphical analogy of differential coefficient, gradient at a point; Liebnitz notation for differential coefficient; differentiation of simple polynomial, exponential functions and sinusoidal functions, rate of change applied to simple functions

Integration: integration as the reverse of differentiation, basic rules of integration for simple polynomial functions, exponential functions and sinusoidal functions, indefinite integrals, definite integrals of simple polynomial functions; concept of the integral as a summation device

Assessment guidance

This unit is internally assessed

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all of the learning outcomes for the unit. The criteria for a pass grade describe the level of achievement required to pass this unit.

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that the learner is able to:**	**To achieve a distinction grade the evidence must show that the learner is able to:**
• manipulate and simplify algebraic, logarithmic and exponential functions • use standard formulae to find surface areas and volumes of regular solids • solve triangular and circular measurement problems involving use of the sine, cosine, tangent and radian functions • use graphical methods to produce answers to simple problems involving algebraic, trigonometric and oscillatory functions • manipulate statistical and scientific data, and produce statistical diagrams and graphical solutions from such data • produce answers to statistical problems involving the determination of mean, median and mode	• apply algebraic laws and trigonometric functions to the solution of realistic engineering problems • apply statistical methods to the analysis of statistical, scientific and experimental data and make realistic estimates and predictions from such an analysis • produce answers to a problem involving the determination of the standard deviation and variance • use graphical methods to find the differential coefficient of simple exponential and sinusoidal functions • differentiate algebraic, exponential and trigonometric functions using the basic rules.	• solve realistic engineering problems which involve the mathematical manipulation and analysis of relatively complex algebraic, exponential and trigonometric functions • apply graphical methods to the solution of engineering problems that involve exponential growth and decay, logarithmic and sinusoidal functions • apply the rules for definite integration to engineering problems that involve summation.

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that the learner is able to:**	**To achieve a distinction grade the evidence must show that the learner is able to:**
• differentiate polynomial and other simple algebraic expressions • use the rules of integration to find indefinite and definite integrals of basic polynomial functions.		

Essential information for teachers

Delivery strategies

This is a core unit and mastery of this unit is essential for further successful study. For this reason, delivery should commence at an early stage in the programme concurrent with core unit *Science for Technicians*.

Prior to embarking on this unit all learners, as a minimum standard, should be able to demonstrate proficiency in the following:

- *numeracy* – notation, real and integer numbers and precedence rules, vulgar fractions, lowest common multiple of and highest common factor, ratios, decimals, standard form, estimation techniques, binary numbers, use a calculator for numerical problems
- *data manipulation* – accuracy and the manipulation of numerical data, simple tally methods, representation of data in the form of simple graphical plots including the use of axes and scales.

Learners (during the delivery of the unit) must be encouraged to use a scientific calculator. They should be able to demonstrate proficiency in the calculator solution of problems that involve; algebraic, trigonometric and statistical functions.

In-course assignments, as well as more formal methods of assessment should be designed to encompass elements from other units, particularly the *Science for Technicians* unit, in addition to monitoring learner performance and providing feedback.

Assessment strategies

Evidence of outcomes can be collected from assignments and formal written assessment. The pass grade specifies the minimum acceptable level required by learners and the internal assessment will cover all the learning outcomes but not necessarily all the topics included in the content. Achievement of a merit grade or a distinction grade will require answers that demonstrate additional depth and breadth of knowledge, as detailed in the assessment evidence.

Grade descriptions

Pass

To achieve a pass, learners must have: a basic level of knowledge of the elementary laws of algebra, including the ability to manipulate indices, simple algebraic formulae and functions; an understanding of the procedures needed to produce and interpret graphs of simple algebraic equations; the ability to determine surface areas and volumes of regular solids.

Learners must have a basic understanding of the elementary trigonometric ratios and radian measure in order to solve problems involving triangles and circles; produce and interpret graphs of simple sinusoidal functions.

Learners must have a basic understanding of the methods used to gather, manipulate and present statistical data in graphical form; a basic level of knowledge and understanding of the statistical techniques needed to determine the mean, median and mode from given data; a basic level of knowledge of the rules of calculus arithmetic and the ability to use these rules for differentiation and integration of simple algebraic and trigonometric functions.

Merit

To achieve a merit, learners must have: a sound level of knowledge of the elementary laws of algebra and the ability to manipulate indices, logarithms, algebraic formulae and functions; a sound understanding of the procedures needed to produce, interpret and apply graphs of algebraic and logarithmic functions to simple engineering variables.

Learners must apply knowledge of sinusoidal functions to simple electrical engineering problems, involving alternating voltages and currents.

Learners must have sound knowledge and understanding of: the methods needed to gather, manipulate and present statistical data in graphical form; the statistical techniques needed to determine the standard deviation and variance from a variety of data; the basic rules of calculus arithmetic; an ability to differentiate algebraic, exponential and trigonometric functions, using these rules is needed.

Distinction

To achieve a distinction, learners must: possess an in-depth level of knowledge and understanding of the elementary laws of algebra; manipulate indices, logarithms, algebraic formulae and functions fluently; thoroughly understand the algebraic and graphical procedures necessary to solve problems involving engineering variables.

Learners must have: an-depth knowledge of trigonometric functions; the ability to apply graphical techniques to the solution of realistic engineering problems that involve exponential growth and decay, logarithmic and sinusoidal functions; a comprehensive knowledge of the methods needed to collate, analyse and display statistical data.

Learners must: possess an in-depth level of knowledge and thorough understanding of the rules of calculus arithmetic; apply the rules for differentiation and definite and indefinite integration; to problems that involve rates of change and summation of engineering variables.

Links

The unit has links with all other analytically-based units, in particular, core unit *Science for Technicians*. An aim of the unit is to provide the necessary foundation for further study of the *Analytical Methods for Engineers* unit within the Higher National Engineering programmes. The outcomes have been carefully selected to meet this aim. Prior to embarking on the Higher National unit a minimum standard of mathematical achievement is required, as quoted in the guidance notes in the Higher National unit. The outcomes within this unit cover in full these elements of algebra, trigonometry, statistics and the calculus, identified as necessary prerequisite knowledge.

The unit also contributes towards the knowledge and understanding for ECS units at level 3.

1.02 Identify solutions to meet technical requirements

1.12 Interpret detailed information from technical sources

1.14 Provide technical information in required formats

6.02 Conduct specified testing of engineering products or assets

6.03 Analyse and interpret the results of engineering tests

7.08 Contribute to the organisation of work activities.

This unit has links with the specialist units which cover aspects of mathematics; another feature of the unit is development of a relatively wide knowledge and understanding of the subject matter. However, the learner should develop the relevant transferable skills required for study both within and beyond this particular award.

Resources

Learning might usefully be enhanced by offering access to a number of computer-aided mathematical learning packages, in addition to the use of recommended textbooks.

Suggested reading

Textbooks

- Bird J O and May A J C – *Technician Mathematics* (Longman Group UK, 1994)
- Tooley M and Dingle L – *National Engineering* (Newnes, 2002)

Key skills

Highlighted here are the key skills that have already been identified in the *Description* section. Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of level 3 key skills evidence are given here. Staff should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Application of number level 3		
When learners are:	**They should be able to develop the following key skills evidence:**	
• producing solutions to mathematical, scientific and engineering problems • producing graphical solutions to problems involving statistical and scientific data	N3.1	Plan, and interpret information from **two** different types of sources, including a large data set.
	N3.2	Carry out multi-stage calculations to do with: a amounts and sizes b scales and proportion c handling statistics d rearranging and using formulae.
	N3.3	Interpret results of your calculations, present your findings and justify your methods. You must use at least **one** graph, **one** chart and **one** diagram.

Information technology level 3		
When learners are:	**They should be able to develop the following key skills evidence:**	
• producing statistical data in the form of tables, charts and diagrams	IT3.3	Present information from different sources for **two** different purposes and audiences. Your work must include at least **one** example of text, **one** example of images and **one** example of numbers.

Problem solving level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• applying mathematical techniques to the solution of scientific and engineering problems	PS3.1 Explore a complex problem, come up with **three** options for solving it and justify the option selected for taking forward. PS3.2 Plan and implement at least **one** option for solving the problem, review progress and revise your approach as necessary. PS3.3 Apply agreed methods to check if the problem has been solved, describe the results and review your approach to problem solving.

Unit 28: Further Mathematics for Technicians

NQF Level 3: BTEC National

Guided learning hours: 60

Unit abstract

Mathematics is an essential tool for any electrical or mechanical engineering technician. This unit has been designed to further enhance learners' knowledge of mathematical principles, particularly for those considering progressing to a higher education qualification in engineering. With this in mind, the learning outcomes offer greater emphasis to the engineering application of mathematics. For example, learners could use an integral calculus method to obtain the root mean square (RMS) value of a sine wave over a half cycle.

The first learning outcome will extend learners' knowledge of graph plotting and will develop the technique of using a graph to solve (find the roots of), for example, a quadratic equation.

Learning outcome 2 involves the use of both arithmetic and geometric progressions for the solution of practical problems. The concept of complex numbers, an essential tool for electrical engineers considering, is also introduced.

Learning outcome 3 considers the parameters of trigonometrical graphs and the resultant wave when two are combined. The use of mathematical formulae in the latter half of this learning outcome enables a mathematical approach to wave combination to be considered.

Finally, in learning outcome 4, calculus techniques are further developed and used to show their application in engineering.

Learning outcomes

On completion of this unit a learner should:

1 Be able to use advanced graphical techniques

2 Be able to apply algebraic techniques

3 Be able to understand how to manipulate trigonometric expressions and apply trigonometric techniques

4 Be able to apply calculus.

Unit content

1 Be able to use advanced graphical techniques

Advanced graphical techniques: graphical solution eg of a pair of simultaneous equations with two unknowns, to find the real roots of a quadratic equation, for the intersection of a linear and a quadratic equation, non-linear laws such as ($y = ax^2 + b,\ y = a + \frac{b}{x}$), by the use of logarithms to reduce laws of type $y = ax^n$ to straight line form, of a cubic equation such as $2x^3 - 7x^2 + 3x + 8 = 0$, recording, evaluating and plotting eg manual, computerised

2 Be able to apply algebraic techniques

Arithmetic progression (AP): first term (a), common difference (d), nth term eg $a + (n-1)d$; arithmetic series eg sum to n terms, $S_n = \frac{n}{2}\{2a + (n-1)d\}$

Geometric progression (GP): first term (a), common ratio (r), nth term eg $a\,r^{n-1}$; geometric series eg sum to n terms, $S_n = \frac{a(r^n - 1)}{r - 1}$, sum to infinity $S_\infty = \frac{a}{1-r}$; solution of practical problems eg compound interest, range of speeds on a drilling machine

Complex numbers: addition, subtraction, multiplication of a complex number in Cartesian form, vector representation of complex numbers, modulus and argument, polar representation of complex numbers, multiplication and division of complex numbers in polar form, polar to Cartesian form and vice versa, use of calculator

Statistical techniques: review of measure of central tendency, mean, standard deviation for ungrouped and grouped data (equal intervals only), variance

3 Be able to understand how to manipulate trigonometric expressions and apply trigonometric techniques

Trigonometrical graphs: amplitude, period and frequency, graph sketching eg sin x, 2 sin x, ½ sin x, sin 2x, sin ½ x for values of x between 0 and 360°; phase angle, phase difference; combination of two waves of the same frequency

Trigonometrical formulae and equations: the compound angle formulae for the addition of sine and cosine functions eg sin (A ± B); expansion of R sin (wt + α) in the form a cos wt + b sin wt and vice versa

4 **Be able to apply calculus**

Differentiation: review of standard derivatives, differentiation of a sum, function of a function, product and quotient rules, numerical values of differential coefficients, second derivatives, turning points (maximum and minimum) eg volume of a rectangular box

Integration: review of standard integrals, indefinite integrals, definite integrals eg area under a curve, mean and RMS values; numerical eg trapezoidal, mid-ordinate and Simpson's rule

Grading grid

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all of the learning outcomes for the unit. The criteria for a pass grade describes the level of achievement required to pass this unit.

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P1 use a graphical technique to solve a pair of simultaneous linear equations P2 solve a practical engineering problem involving an arithmetical progression P3 solve a practical engineering problem involving an geometric progression P4 perform the two basic operations of multiplication and division to a complex number in both rectangular and polar form, to demonstrate the different techniques P5 calculate the mean, standard deviation and variance for a set of ungrouped data P6 calculate the mean, standard deviation and variance for a set of grouped data	M1 use the laws of logarithms to reduce an engineering law of the type $y = ax^n$ to straight line form, then using logarithmic graph paper, plot the graph and obtain the values for the constants a and n M2 use complex numbers to solve a parallel arrangement of impedances giving the answer in both Cartesian and polar form M3 use differential calculus to find the maximum/minimum for an engineering problem.	D1 using a graphical technique determine the single wave resulting from a combination of two waves of the same frequency and then verify the result using trigonometrical formulae D2 use numerical integration and integral calculus to analyse the results of a complex engineering problem.

Grading criteria			
To achieve a pass grade the evidence must show that the learner is able to:		To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P7	sketch the graph of a sinusoidal trigonometrical function and use it to explain and describe amplitude, periodic time and frequency		
P8	use two of the compound angle formulae and verify their relationship		
P9	find the differential coefficient for three different functions to demonstrate the use of function of a function and the product and quotient rules		
P10	use integral calculus to solve two simple engineering problems involving the definite and indefinite integral.		

Essential guidance for tutors

Delivery

Although this unit can be delivered on its own, it requires learners to have successfully completed *Unit 4: Mathematics for Technicians* or an equivalent before attempting it. For this reason it should be delivered at a later stage in the course, after a suitable foundation in mathematics and engineering principles has been established.

Every opportunity should be taken to apply and contextualise the underpinning mathematical principles to suit learners' chosen engineering specialism. Tutors could provide a selection of well-prepared, vocationally relevant examples and assignments that are tailored to area-specific programmes of study, as well as selecting specific applications from the suggested option.

Regular opportunities (eg classroom exercises) to address the relevant techniques should be provided as part of formative assessment. Constant feedback, using additional formative tests and coursework that falls outside the formal summative assessment, may be used to aid learning without necessarily being graded.

The unit content does not need to be taught or assessed in order and it is left to centres to decide on their preferred order of delivery.

Note that the use of 'eg' in the content is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'eg' needs to be taught or assessed.

Assessment

P1 and M1 are probably best assessed through an assignment with learners being given different equations for a meaningful task (eg two operatives producing a certain number of assemblies) for P1.

For M1 learners will need to provide evidence that they can reduce an engineering law (eg gas pressure and temperature $T = ap^{y}$, current and voltage $I = VR^{k}$) to straight line form, then use logarithmic graph paper to plot the graph and obtain values for the constants. This is probably best achieved with an assignment in which learners are each given different values.

P2 and P3 can be combined into one assignment, again relevant to an engineering problem (eg the drilling of bore holes for an arithmetic progression solution and the calculation of drill speeds for a geometric progression solution).

For P4 learners could be given different values to demonstrate the two basic operations and this could be linked to M2 to form one assignment.

P5 and P6 could also be linked and assessed by an assignment or short formal test with a relevant application (eg values of resistors, quality control of a product, overtime working).

P7 and P8 could be assessed by a short formal class test. Alternatively an assignment could be used with different values for the graphical output given to different learners. Either approach would help ensure answers are authentic.

P9, P10 and M3 are possibly best assessed as a short exercise or assignment, with learners being given a list of the standard differential coefficients and integrals to use. For P9 each of the questions could be written to assess all the three rules in turn. P10 requires a simple engineering problem (eg indefinite integral given information to find value of constant and hence required equation, definite integral such as area under a curve). M3 is possibly best linked to P9 and P10 with M3 assessing an engineering problem (eg use of differentiation to find the dimensions of a rectangular box to give the maximum volume).

The merit criteria need to build upon the pass criteria, and as such may form an extension to an assessment containing several of the pass criteria as already indicated.

Evidence for the distinction criteria needs to show that learners have a more in-depth knowledge and understanding. Both the distinction criteria could be assessed by a written assignment. For D1 learners firstly need to use a graphical technique to obtain the single wave resulting from a combination of two waves of the same frequency. Each learner could be given a slightly different equation by varying the values of A and B (eg $V_1 = A\sin\left(100\pi t + \frac{2\pi}{5}\right)$, $V_2 = B\sin\left(100\pi t - \frac{2\pi}{9}\right)$). Learners should be encouraged to use a computer package for recording, evaluating and possibly plotting a range of values (eg t from 0 to 0·02s). By using the double angle formulae (eg $Sin\,(A \pm B)$) and the expansion of $R\sin(wt \pm \alpha)$ learners could verify their results.

Ideally D2 should provide a comparison between one, two or all three of the numerical integration methods and integration by calculus (eg evaluation of the distance traveled in the first second when a guitar string is plucked about its centre, given an equation for its velocity).

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

Unit 4: Mathematics for Technicians is an essential prerequisite for this unit and as such must be studied prior to this unit. The unit also links with all other analytically-based mechanical and electrical principles units. It is, therefore, important that these links are reinforced by delivering appropriate specialist units for the learners' own disciplines concurrently.

Learners completing this unit together with *Unit 4: Mathematics for Technicians* will be well equipped for progression onto BTEC Higher National Certificate/Diploma courses and first year engineering degree qualifications.

Essential resources

Learners will need to use an electronic scientific calculator and have access to software packages that support the concepts and principles and their application to engineering.

Indicative reading for learners

Bird J — *Engineering Mathematics* (Newnes, 2003) ISBN 0750657766

Tooley M and Dingle L — *BTEC National Engineering* (Newnes, 2002) ISBN 0750651660

Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Application of number Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• producing and evaluating solutions to engineering problems using a range of mathematical techniques • producing graphical solutions to problems involving statistical and scientific data.	N3.1 Plan an activity and get relevant information from relevant sources. N3.2 Use this information to carry out multi-stage calculations to do with: a amounts or sizes b scales or proportion c handling statistics d using formulae. N3.3 Interpret the results of your calculations, present your findings and justify your methods.

B1 PERMISSION AND QUALIFICATIONS

National Level Engineering Questionnaires

The purpose of this research is to explore the use of technology in education.

Questionnaires form one part of the research. There are three questionnaires in total, spread over the academic year.

All participants will remain anonymous. All information will be treated with strict confidentiality. If you decide that you do not wish to participate in the research, you have the right to withdraw at any stage.

The research is to be assessed by Plymouth University and Plymouth College of Further Education.

Personal details

Surname:	
Forename(s)	
Course code	
Tutor	
Date of Birth (dd/mm/yy)	
Gender (male/female)	

Employment details (Day release, Block release & Part-time students)

Name of employer	
Job title	

Dyslexia

Have you been diagnosed as being dyslexic? Yes/no ☐

Participants' Declaration

I agree to take part in this survey.

Signed:____________________________ Date__________________

Entry Qualifications

Name………………………………………… **Course Code**……………………..

Academic Year ……………………………….

Please complete the following qualification list.

On application for the National Level Course, I had the following qualifications:

SUBJECT	YES/NO	GRADE	YEAR
BTEC First Diploma			
Intermediate GNVQ			
Four (or more) GCSE grades A*-C		N/A	
Maths GCSE A*-C			
English GCSE A*-C			
ICT GCSE A*-C			
College Entrance Test			

FOLLOW UP INTERVIEWS

If you don't mind being interviewed as a follow up to this, and the three questionnaires towards the end of the academic year, please confirm this by signing below. However, if you decide to change your mind you have the right to withdraw at any stage.

I confirm that I am willing to be interviewed as a follow up to the questionnaires.

Signed: ……………………………………………………Date:…………………

B2 **TERMLY QUESTIONNAIRES**

Name………………………………………Course/Class Code………

Academic Year…………………………...

National Level Engineering

Initial Questionnaire

Please answer the following questions by circling the appropriate result. If there is more than one possible answer, the question will give you more specific instructions on how to answer it.

1. How would you rate your ability in mathematics?

Extremely Good	Very Good	Good	Average	Poor	Very Poor	Extremely Poor

2. How would you compare your mathematics ability to others in your group?

Very Much Better	Much Better	Better	Same	Worse	Much Worse	Very Much Worse

3. How would you compare your mathematics ability to people of your age in general?

Very Much Better	Much Better	Better	Same	Worse	Much Worse	Very Much Worse

4. Do you find it easy to catch up mathematics work if you have been absent from class?

Always	Usually	Occasionally	Never

5. Please explain below what you would do when you found a topic area in mathematics difficult to understand:

……………………………………………………………………..…………

……………………………………………………………………………..

……………………………………………………………………………..

……………………………………………………………………………..

6.

(a) Would it be useful to have a replay or review of previous mathematics lessons available so that the lesson could be looked at again at another time?

Yes No Don't Know

Please give reasons for your choice of answer

…………………………………………………………………………..

…………………………………………………………………………..

Put a tick in the box next to any of the sentences that describe what you would do. You can tick more than one box

(b) If you answered YES to part (a), which of the following would you look at?

- ☐ An individual mathematics lesson
- ☐ Parts of an individual mathematics lesson
- ☐ A complete set of maths lessons covering a topic area
- ☐ Parts of a complete set of mathematics lessons covering a topic area
- ☐ Background and basic mathematics needed for the course

(c) If you answered YES to part (a), why would you look at these?

- ☐ To cover work I had missed
- ☐ To cover work I didn't understand
- ☐ To remind me of basic underlying techniques
- ☐ To revise for exams
- ☐ Other (Please explain) ………………………………..

…………………………………………………………………………..

7. Do you find mathematics easy to remember?

Always Usually Occasionally Never

8. *Put a tick in the box next to any of the sentences that describe what you would do. You can **only** tick one box*

Do you take time to review your mathematics class work in your own time?

- ☐ Yes, after every lesson
- ☐ Yes, after some lessons
- ☐ Yes, but only for revision
- ☐ No, never

9. *Put a tick in the box next to any of the sentences that describe what you would do. You can tick more than one box*

How do you revise for mathematics tests?

- ☐ Revision sheets
- ☐ Redo class worksheets
- ☐ Use textbooks
- ☐ Read through class notes
- ☐ I don't revise
- ☐ Other (Please explain) ………………………………..

…………………………………………………………………………..

10. *Put a tick in the box next to any of the sentences that apply to you. You can tick more than one box*

When I learn a new topic in mathematics

- ☐ I usually understand it straight away
- ☐ I understand parts of it straight away
- ☐ I find some topics easy and some difficult
- ☐ It takes me a long time to grasp
- ☐ I need a lot of explanation
- ☐ I have to work hard to understand
- ☐ I need extra help to understand

11. *Put a tick in the box next to any of the sentences that apply to you. You can tick more than one box*

If I miss a mathematics lesson

- ☐ I don't miss mathematics lessons
- ☐ I find it difficult to catch up
- ☐ I need extra help to understand the topic
- ☐ I use textbooks
- ☐ I don't catch up the lesson
- ☐ I copy the notes from a friend
- ☐ I attempt the class worksheet
- ☐ I ask a friend to explain it

12. *Put a tick in the box next to any of the sentences that apply to you. You can tick more than one box*

If I find a topic area difficult to understand

- ☐ I ask for help from the lecturer during class
- ☐ I ask for help from a friend during class
- ☐ I ask for help from the lecturer after class
- ☐ I ask for help from a friend after class
- ☐ I look the topic up in a text book
- ☐ I ask for help from a relative
- ☐ I search the internet for information
- ☐ I do nothing

13. *On each of the number scales below circle the value that corresponds closest to what you think.*

How do you feel about mathematics?

I intensely dislike mathematics						I intensely like mathematics
1	2	3	4	5	6	7

Mathematics is unimportant						Mathematics is essential
1	2	3	4	5	6	7

Support in mathematics is unnecessary						Support in mathematics is essential
1	2	3	4	5	6	7

14. *On each of the number scales below circle the value that corresponds closest to what you think.*

How do you feel about using computers?

I intensely dislike using computers						I intensely like using computers
1	2	3	4	5	6	7

Using computers is unimportant						Using computers is essential
1	2	3	4	5	6	7

Support in using computers is unnecessary						Support in using computers is essential
1	2	3	4	5	6	7

15. How do you rate your ability in using computers for general tasks?

Extremely Good	Very Good	Good	Average	Poor	Very Poor	Extremely Poor

16. How would you compare your ability in using computers for general tasks to others in your group?

Very Much Better	Much Better	Better	Same	Worse	Much Worse	Very Much Worse

17. How would you compare your ability in using computers for general tasks to people of your age in general?

Very Much Better	Much Better	Better	Same	Worse	Much Worse	Very Much Worse

18. Do you think it is possible to learn mathematics via the Internet?

    Yes   No   Don't Know

    Please give reasons for your choice of answer

    …………………………………………………………………………..

    …………………………………………………………………………..

19. *Put a tick in the box next to any of the appropriate words. You can tick more than one box*

    When you need to practise some mathematics topics, which of the following would you use?

    - ☐ Textbooks
    - ☐ Internet
    - ☐ Worksheets
    - ☐ Revision sheets
    - ☐ Class notes
    - ☐ Ask someone to help

20. If mathematics work, specifically written for your course, were available over the Internet, would you be inclined to use it?

    Not at all   Reluctantly   Sometimes   Definitely

You have now completed the questionnaire. Thank you for your time.

Name………………………………………Course/Class Code………………….
Academic Year……………………………...

National Level Engineering

Mid Questionnaire

Please answer the following questions by circling the appropriate result. If there is more than one possible answer, the question will give you more specific instructions on how to answer it.

1. How would you rate your ability in mathematics now?

Extremely Good	Very Good	Good	Average	Poor	Very Poor	Extremely Poor

2. How would you compare your mathematics ability to others in your group now?

Very Much Better	Much Better	Better	Same	Worse	Much Worse	Very Much Worse

3. How would you compare your mathematics ability to people of your age in general now?

Very Much Better	Much Better	Better	Same	Worse	Much Worse	Very Much Worse

4. *On each of the number scales below circle the value that corresponds closest to what you think.*

How do you feel about mathematics now?

I intensely dislike mathematics — I intensely like mathematics

1 2 3 4 5 6 7

Mathematics is unimportant — Mathematics is essential

1 2 3 4 5 6 7

Support in mathematics is unnecessary — Support in mathematics is essential

1 2 3 4 5 6 7

5. Do you find mathematics easy to remember?

Always Usually Occasionally Never

6. Do you think it is possible to learn mathematics via the Internet?

Yes No Don't Know

Please give reasons for your choice of answer:

…………………………………………………………………………..

…………………………………………………………………………..

7. *Please circle your answers from the following lists:*

(a) Mathematics work, specifically written for your course, is available over the Internet. Would you be inclined to use it?

Not at all Reluctantly Sometimes Definitely

(b) Have you heard about the mathematics lessons available on Blackboard?

Yes No

(c) Have you used or looked at the mathematics lessons available on Blackboard?

Yes No

Please give reasons for your choice of answer:

…………………………………………………………………………..

…………………………………………………………………………..

If you answered YES to 7(c), please continue from question number 8.

If you answered NO to 7(c), please go straight to question number 14.

8. Was it easy to find the mathematics lessons you wanted on Blackboard?

Yes No

Please give reasons for your choice of answer:

…………………………………………………………………………..

…………………………………………………………………………..

9. How long (on average) do you spend looking at the mathematics lessons on Blackboard when you access them?

I don't access them	Less than 5 minutes	Between 5 to 30 minutes	Between ½ to 1 hour	More than 1 hour

10. (a) Has it been useful to have replays or reviews of previous mathematics lessons available so that the lesson could be looked at again at another time?

Yes No Don't Know

Please give reasons for your choice of answer:

…………………………………………………………………………..

…………………………………………………………………………..

Put a tick in the box next to any of the sentences that describe what you would do. You can tick more than one box.

(b) Which of the following have you replayed or reviewed at another time?

- ☐ Background and basic mathematics needed for the course
- ☐ An individual mathematics lesson
- ☐ Parts of an individual mathematics lesson
- ☐ A complete set of mathematics lessons covering a topic area
- ☐ Parts of a complete set of mathematics lessons covering a topic area

Put a tick in the box next to any of the sentences that describe what you would do. You can tick more than one box.

(c) Why did you replay or review the mathematics lesson at another time? *(You can tick more than one box).*

- ☐ To cover work I had missed
- ☐ To cover work I didn't understand
- ☐ To remind me of basic underlying techniques
- ☐ To revise for exams
- ☐ Out of curiosity
- ☐ Other (Please explain) ………………………………..

…………………………………………………………………………..

(d) Looking at your answers to (c), which was the main reason?

……………………………………………………………………………..

(e) Have the mathematics lessons on Blackboard made it easier to keep up with mathematics work?

Yes No

Please give reasons for your choice of answer:

……………………………………………………………………………..

……………………………………………………………………………..

Put a tick in the box next to any of the sentences that describe what you would do. You can tick more than one box.

(f) What lesson(s) did you replay?

- ☐ Algebra
  - ☐ Powers and indices
  - ☐ Simplifying expressions
  - ☐ Solving equations
  - ☐ Transpositions
  - ☐ Simultaneous equations
- ☐ Shape & Trigonometry
  - ☐ Surface areas
  - ☐ Volumes
  - ☐ Trigonometry and Pythagoras
  - ☐ Circular measure
- ☐ Graphs
  - ☐ Algebraic graphs
  - ☐ Simultaneous graphs
  - ☐ Trigonometric graphs
  - ☐ Waveforms
- ☐ Statistics
  - ☐ Statistical diagrams
  - ☐ Averages
  - ☐ Dispersion

11. *Put a tick in the box next to any of the sentences that describe what you would do. You can tick more than one box*

(a) From where did you access the mathematics lessons on Blackboard?

- ☐ College
- ☐ Home
- ☐ Workplace
- ☐ Other (Please explain): ………………………………..

………………………………………………………………………..

(b) What factors affected where you accessed the mathematics lessons on Blackboard?

- ☐ Computer availability
- ☐ Access costs
- ☐ Time factors
- ☐ Other (Please explain): ………………………………..

……………………………………………………………………..

12. How frequently have you accessed the mathematics lessons on Blackboard?

Only once Occasionally Often Regularly

13.
(a) Would you recommend the mathematics lessons on Blackboard to others?

Yes No

Please give reasons for your choice of answer:

………………………………………………………………………..

………………………………………………………………………..

(b) How could the mathematics lessons on Blackboard be improved?

……………………………………………………………………………..

……………………………………………………………………………..

……………………………………………………………………………..

If you answered YES to question 7(c) and continued from question 8 through to question 13, please go straight to question number 16.

If you answered NO to question 7(c), please continue from question number 14.

14. *Put a tick in the box next to any of the sentences that describe what you needed. You can tick more than one box*

I needed support in the following lessons:

- ☐ Algebra
  - ☐ Powers and indices
  - ☐ Simplifying expressions
  - ☐ Solving equations
  - ☐ Transpositions
  - ☐ Simultaneous equations
- ☐ Shape & Trigonometry
  - ☐ Surface areas
  - ☐ Volumes
  - ☐ Trigonometry and Pythagoras
  - ☐ Circular measure
- ☐ Graphs
  - ☐ Algebraic graphs
  - ☐ Simultaneous graphs
  - ☐ Trigonometric graphs
  - ☐ Waveforms
- ☐ Statistics
  - ☐ Statistical diagrams
  - ☐ Averages
  - ☐ Dispersion

15.(a) Was it easy to get the support you needed in mathematics?

Yes No Not applicable

Please give reasons for your choice of answer:

…………………………………………………………………………

…………………………………………………………………………..

Put a tick in the box next to any of the sentences that describe what you would do. You can tick more than one box

(b) If you answered YES to part (a), what type of support was needed?

- ☐ An individual mathematics lesson
- ☐ Parts of an individual mathematics lesson
- ☐ A complete set of mathematics lessons covering a topic area
- ☐ Parts of a complete set of mathematics lessons covering a topic area
- ☐ Background and basic mathematics needed for the course

Put a tick in the box next to any of the sentences that describe what you would do. You can tick more than one box.

(c) If you answered YES to part (a), why was the support needed?

- ☐ To cover work I had missed
- ☐ To cover work I didn't understand
- ☐ To remind me of basic underlying techniques
- ☐ To revise for exams
- ☐ Other (Please explain): ………………………………..

…………………………………………………………………………..

Whatever your answer to question 7(c), please continue from question number 16.

16. Put a tick in the box next to any of the sentences that describe what you would do. **You can only tick one box**

What types of mathematics support would you prefer?

- ☐ Internet resources
- ☐ Individual tuition
- ☐ Extra group work sessions
- ☐ Other (Please explain) ………………………………..

…………………………………………………………………………..

17. *On each of the number scales below circle the value that corresponds closest to what you think.*

How do you feel about using computers now?

I intensely dislike using computers						I intensely like using computers
1	2	3	4	5	6	7

Using computers is unimportant						Using computers is essential
1	2	3	4	5	6	7

Support in using computers is unnecessary						Support in using computers is essential
1	2	3	4	5	6	7

In the following questions, please circle the most appropriate answer for you.

18. How do you rate your ability in using computers for general tasks now?

Extremely Good	Very Good	Good	Average	Poor	Very Poor	Extremely Poor

19. How would you compare your ability in using computers for general tasks to others in your group now?

Very Much Better	Much Better	Better	Same	Worse	Much Worse	Very Much Worse

20. How would you compare your ability in using computers for general tasks to people of your age in general now?

Very Much Better	Much Better	Better	Same	Worse	Much Worse	Very Much Worse

You have now completed the questionnaire. Thank you for your time.

Name……………………………………….Course/Class Code……………….
Academic Year……………………………...

National Level Engineering

Final Questionnaire

Please answer the following questions by circling the appropriate result. If there is more than one possible answer, the question will give you more specific instructions on how to answer it.

1. How would you rate your ability in mathematics now?

Extremely Good	Very Good	Good	Average	Poor	Very Poor	Extremely Poor

2. How would you compare your mathematics ability to others in your group?

Very Much Better	Much Better	Better	Same	Worse	Much Worse	Very Much Worse

3. How would you compare your mathematics ability to people of your age in general?

Very Much Better	Much Better	Better	Same	Worse	Much Worse	Very Much Worse

4. *On each of the number scales below circle the value that corresponds closest to what you think.*

How do you feel about mathematics?

I intensely dislike mathematics — I intensely like mathematics

1 2 3 4 5 6 7

Mathematics is unimportant — Mathematics is essential

1 2 3 4 5 6 7

Support in mathematics is unnecessary — Support in mathematics is essential

1 2 3 4 5 6 7

5. How frequently have you used or looked at the mathematics lessons available on Blackboard?

Never	Occasionally	Often	Regularly

6. How long (on average) do you spend looking at the mathematics lessons available on Blackboard when you access them?

I don't access them	Less than 5 minutes	Between 5 to 30 minutes	Between ½ to 1 hour	More than 1 hour

7. Put a tick in the box next to any of the sentences that describe what you would do. You can **only** tick one box.

What types of mathematics support would you prefer?

☐ Internet resources

☐ Lessons and notes posted on Blackboard

☐ Individual tuition

☐ Extra group work sessions

☐ Other (Please explain) ………………………………..

………………………………………………………………………..

8. *On each of the number scales below circle the value that corresponds closest to what you think.*

How do you feel about using computers now?

I intensely dislike using computers — I intensely like using computers

1 2 3 4 5 6 7

Using computers is unimportant — Using computers is essential

1 2 3 4 5 6 7

Support in using computers is unnecessary — Support in using computers is essential

1 2 3 4 5 6 7

9. How do you rate your ability in using computers for general tasks now?

Extremely Good	Very Good	Good	Average	Poor	Very Poor	Extremely Poor

10. How would you compare your ability in using computers for general tasks to others in your group now?

Very Much Better	Much Better	Better	Same	Worse	Much Worse	Very Much Worse

11. How would you compare your ability in using computers for general tasks to people of your age in general now?

Very Much Better	Much Better	Better	Same	Worse	Much Worse	Very Much Worse

12. Have you heard of the virtual learning environment, Blackboard?

Yes No

13. Have you used or looked at the mathematics lessons available on Blackboard?

Yes No

Please give reasons for your choice of answer:

…………………………………………………………………………..

…………………………………………………………………………..

If you answered YES to question 13, please continue from question 14.

If you answered NO to question 13, please go straight to question 23.

Continue from here if you answered YES to question 13, otherwise, please go to question 23.

14. *Put a tick in the box next to any of the sentences that describe what you would do. You can tick more than one box.*

(a) From where did you access the mathematics lessons available on Blackboard?

- ☐ College
- ☐ Home
- ☐ Workplace
- ☐ Other (Please explain): ………………………………..

………………………………………………………………………..

(b) What factors affected where you accessed the mathematics lessons available on Blackboard?

- ☐ Computer availability
- ☐ Access costs
- ☐ Time factors
- ☐ Other (Please explain): ………………………………..

……………………………………………………………………..

(c) Was it easy to find the mathematics lessons you wanted on Blackboard?

Yes No

Please give reasons for your choice of answer:

………………………………………………………………………..

………………………………………………………………………..

15. (a) Has it been useful to have replays or reviews of previous mathematics lessons available so that the lesson could be looked at again at another time?

Yes No

Please give reasons for your choice of answer:

…………………………………………………………………………..

…………………………………………………………………………..

Put a tick in the box next to any of the sentences that describe what you would do. You can tick more than one box.

(b) If you answered YES to part (a), which of the following did you replay or review?

- ☐ An individual mathematics lesson
- ☐ Parts of an individual mathematics lesson
- ☐ A complete set of mathematics lessons covering a topic area
- ☐ Parts of a complete set of mathematics lessons covering a topic area
- ☐ Background and basic mathematics needed for the course

(c) If you answered YES to part (a), why did you replay or review the previous mathematics lessons?

- ☐ To cover work I had missed
- ☐ To cover work I didn't understand
- ☐ To remind me of basic underlying techniques
- ☐ To revise for exams
- ☐ Out of curiosity
- ☐ Other (Please explain): ………………………………..

…………………………………………………………………………..

(d) If you answered YES to part (a), have the mathematics lessons available on Blackboard made it easier to keep up with mathematics work?

Yes No

Please give reasons for your choice of answer:

…………………………………………………………………………..

…………………………………………………………………………..

16. Have the mathematics lessons available on Blackboard provided you with adequate support?

Always | Usually | Occasionally | Never

17. *Put a tick in the box next to any of the sentences that describe what you accessed. You can tick more than one box*

Which mathematics lessons did you access from Blackboard?

- ☐ Algebra
  - ☐ Powers and indices
  - ☐ Simplifying expressions
  - ☐ Solving equations
  - ☐ Transpositions
  - ☐ Simultaneous equations
- ☐ Shape & Trigonometry
  - ☐ Surface areas
  - ☐ Volumes
  - ☐ Trigonometry and Pythagoras
  - ☐ Circular measure
- ☐ Graphs
  - ☐ Algebraic graphs
  - ☐ Simultaneous graphs
  - ☐ Trigonometric graphs
  - ☐ Waveforms
- ☐ Statistics
  - ☐ Statistical diagrams
  - ☐ Averages
  - ☐ Dispersion
- ☐ Differentiation
  - ☐ Polynomial differentiation
  - ☐ Exponential differentiation
  - ☐ Trigonometric Differentiation
  - ☐ Differential applications

- ☐ Integration
  - ☐ Definite and indefinite integration
  - ☐ Area under a curve and differential equations
- ☐ Applied Problems
  - ☐ Sine and Cosine rules
  - ☐ Vectors
  - ☐ Algebraic solution of quadratic equations
  - ☐ Proportion and exponential graphs

18. Do you think it is possible to learn mathematics by using the mathematics lessons available on Blackboard?

    Yes No

    Please give reasons for your choice of answer:

    …………………………………………………………………………..

    …………………………………………………………………………..

19. Do the mathematics lessons available on Blackboard help you to remember mathematics more easily?

    Always Usually Occasionally Never

20. Do the mathematics lessons available on Blackboard help you to understand mathematics more?

    Always Usually Occasionally Never

21. What do you feel are the benefits and problems associated with the mathematics lessons available on Blackboard?

Benefits	Problems

22. (a) Would you recommend the mathematics lessons available on Blackboard to others?

Yes No

Please give reasons for your choice of answer:

…………………………………………………………………………..

…………………………………………………………………………..

(b) How could the mathematics lessons available on Blackboard be improved?

…………………………………………………………………………..

…………………………………………………………………………..

…………………………………………………………………………..

If you answered YES to question 13, you have now finished the questionnaire. Thank you for your time.

If you answered NO to question 13, please continue from question 23.

23. *Put a tick in the box next to any of the appropriate words. You can tick more than one box.*

If you need to practise some mathematics topics, which of the following would you use?

- ☐ Textbooks
- ☐ Internet
- ☐ Worksheets
- ☐ Revision sheets
- ☐ Class notes
- ☐ Ask someone to help

24. Do you think it is possible to learn mathematics via the Internet?

Yes No

Please give reasons for your choice of answer:

……………………………………………………………………………..

……………………………………………………………………………..

25. *Put a tick in the box next to any of the sentences that apply to you. You can tick more than one box to complete the sentence.*

If I miss a mathematics lesson ………..….

- ☐ I don't miss mathematics lessons
- ☐ I find it difficult to catch up
- ☐ I need extra help to understand the topic
- ☐ I use textbooks
- ☐ I don't catch up the lesson
- ☐ I copy the notes from a friend
- ☐ I attempt the class worksheet
- ☐ I ask a friend to explain it

26. *Put a tick in the box next to any of the sentences that describe what you would do. You can **only** tick one box*

Do you take time to review your mathematics class work in your own time?

- ☐ Yes, after every lesson
- ☐ Yes, after some lessons
- ☐ Yes, but only for revision
- ☐ No, never

27. *Put a tick in the box next to any of the sentences that apply to you. You can tick more than one box to complete the sentence.*

If I find a topic area difficult to understand

- ☐ I ask for help from the lecturer during class
- ☐ I ask for help from a friend during class
- ☐ I ask for help from the lecturer after class
- ☐ I ask for help from a friend after class
- ☐ I look the topic up in a text book
- ☐ I ask for help from a relative
- ☐ I do nothing

28. *Put a tick in the box next to any of the sentences that apply to you. You can tick more than one box*

When I learn a new topic in mathematics

- ☐ I usually understand it straight away
- ☐ I understand parts of it straight away
- ☐ I find some topics easy and some difficult
- ☐ It takes me a long time to grasp
- ☐ I need a lot of explanation
- ☐ I have to work hard to understand
- ☐ I need extra help to understand

29. Do you find mathematics easy to remember?

Always Usually Occasionally Never

30. *Put a tick in the box next to any of the sentences that describe what you would do. You can tick more than one box*

Which lesson topics required extra support?

- ☐ Algebra
  - ☐ Powers and indices
  - ☐ Simplifying expressions
  - ☐ Solving equations
  - ☐ Transpositions
  - ☐ Simultaneous equations
- ☐ Shape & Trigonometry
  - ☐ Surface areas
  - ☐ Volumes
  - ☐ Trigonometry and Pythagoras
  - ☐ Circular measure
- ☐ Graphs
  - ☐ Algebraic graphs
  - ☐ Simultaneous graphs
  - ☐ Trigonometric graphs
  - ☐ Waveforms
- ☐ Statistics
  - ☐ Statistical diagrams
  - ☐ Averages
  - ☐ Dispersion
- ☐ Differentiation
  - ☐ Polynomial differentiation
  - ☐ Exponential differentiation
  - ☐ Trigonometric Differentiation
  - ☐ Differential applications
- ☐ Integration
  - ☐ Definite and indefinite integration
  - ☐ Area under a curve and differential equations

☐ Applied Problems →
- ☐ Sine and Cosine rules
- ☐ Vectors
- ☐ Algebraic solution of quadratic equations
- ☐ Proportion and exponential graphs

31. Have you had any extra mathematics support over the year?

Yes No

If you answered YES, please describe what support you have had.

…………………………………………………………………………..

…………………………………………………………………………..

…………………………………………………………………………..

……………………………………………………………………………..

You have now completed the questionnaire. Thank you for your time.

B3 **INTERVIEW QUESTIONS**

Individual Interview Questions (VLE Set Up)

Blackboard

1. What were the initial financial set-up costs for Blackboard?

2. What were the ongoing costs?

3. What implications were there to the college computer systems in terms of upgrading?

4. How long did it take to implement?

5. How many staff were involved? – What time did they spend, what costs and what training was needed?

6. What problems were encountered and how were they overcome?

7. What were the benefits and disadvantages of the new system?

8. What take up, by areas was there across the college?

9. What staff/ student usage was there?

10. How easy did staff/students find the system to use?

11. Was it necessary to train staff to use the system? What time costs were involved with this?

Moodle

12. Why was the system switched over to Moodle?

13. What problems were encountered during switch over and how were they overcome?

14. What are the benefits and disadvantages of the new system?

15. What were the initial financial set-up costs for Moodle?

16. What are the ongoing costs?

17. What implications were there to the college computer systems in terms of upgrading?

18. How long did it take to implement?

19. How many staff were involved? – What time did they spend, what costs and what training was needed?

20. What take up, by areas is there across the college?

21. What staff/ student usage is there?

22. How easy do staff/students find the new system to use?

23. Is it necessary to train staff to use the new system? What time costs are involved with this?

Future

24. What provisions are being made for updating?

25. What are the implications involved in updating?

26. What is the take up of the course slots for Blackboard/Moodle?

27. Are all the course sites active? Why/not?

28. What breakdown of external/internal use is there?

29. How will this fit into the wider picture of a city-wide learning platform?

30. What effect is this likely to have on future job roles for both IT support staff and lecturers?

31. What changes of focus have been brought about by its implementation?

32. How viable is the resource for the future?

Group Interview Questions (Students)

1. Do you believe that your ability in mathematics has changed over the past year?

- What do you think has caused the change?
    - Why not?
- Has your understanding improved?
- What examples can you give to support this?
- In what way has it improved?
    - Why not?
- Has this changed your attitude in any way?
- In what way has it changed?
    - Why not?
- Has technology had any effect on any of these changes?
- Give examples of where this has been effected, and what technology it was
- In what way has it had an effect?
    - Why not?

2. Do you believe that your ability in using computers has changed over the past year?

- What do you think has caused the change?
    - Why not?
- Has your understanding improved?
- What examples are there to show this?
- In what way has it improved?
    - Why not?
- Has this changed your attitude in any way?
- In what way has it changed?
    - Why not?

- Has mathematics had any effect on any of these changes?
- What examples are there to support this?
- In what way has it had an effect?
    - Why not?

3. Mathematics lessons for your course have been available over the internet on Blackboard.

- Have you used any of these lessons?

USERS

Looking at accessing lessons from Blackboard

- How did you spend your time?
- Why did you use the lessons?
- What did you expect from the lessons?
- What problems were there in using the lessons?
- What do you feel you got from using the lessons?

NON USERS

- Why didn't you use the lessons?
- What would make you use the lessons?
- What would you expect from the lessons?
- What problems would you anticipate with this approach?

4. Focusing on the technology and the format of the lessons, please describe a good mathematics lesson you have used from Blackboard.

- What was good about it?
- What did you like?
- What did you dislike?
- What would you change?
- What did you find with regards to accessibility?
- What concerns do you have?

- Has this affected your learning in any way?

5. Focusing on the technology and the format of the lessons, please describe a bad mathematics lesson you have used from Blackboard.

    - What was bad about it?
    - What did you like?
    - What did you dislike?
    - What would you change?
    - What did you find with regards to accessibility?
    - What concerns do you have?
    - Has this affected your learning in any way?

Individual Interview Questions (Students)

1. Are you comfortable with the level of mathematics you have been learning? Why/not?
2. What methods do you use to help you remember mathematics? How do these help? Why?
3. Do you review you mathematics work after lessons? Why/not?
4. How do you practise mathematics? Why/not?
5. What do you differently to revise for examinations? Why/not?
6. How do you catch up lessons you miss? Why/not?
7. What methods do you use to overcome difficulties with your mathematics? How do these help? Why?
8. What topic areas did you find most difficult? Why? What did you do to help you understand these topics? Why?
9. What would be the best support system for you? Why?
10. Has the mathematics you have learnt on this course been applied in any other subject areas or your work place? How has it been applied, and why?
11. Do you feel that your final mathematics grade was a true reflection of your mathematics ability? Why/not?
12. Learners can be classed as active or passive by the methods they use to learn. What characteristics would you expect in an active learner? What characteristics would you expect in a passive learner? Do you regard yourself as an active or passive learner? Why?
13. Are you comfortable with using computers for finding information? Why/not?
14. Have you used internet notes to help you with mathematics topics? Why/not?
15. What is the college virtual learning environment used for?
16. How do you use the resources on Blackboard/Moodle?
17. What is effective, what is useful and why?
18. Are discussion boards a useful feature? Why/not?
19. What technical difficulties have you encountered? How were they resolved?

20. Did you use the resources before or after lessons? What difference did it make to your learning?

21. How does a virtual resource compare to the real classroom situation?

22. How many of your lecturers have resources on Blackboard/Moodle?

23. Who encourages you to use the resources?

24. Have you used the Blackboard/Moodle resource to help you with your mathematics? Why/not?

25. How do you rate the Blackboard/Moodle resource in terms of mathematics support on a scale of 1 to 10, with 1 being poor and 10 being good? Why?

26. Does your employer have access to the virtual resources? Is it/would it be useful for them to have access? Why/not?

APPLIED PROBLEMS

Proportion

&

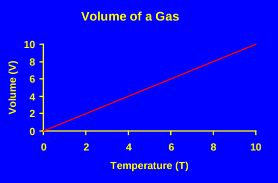
Exponential Graphs

Applied Problems

Proportion

Proportion

Direct

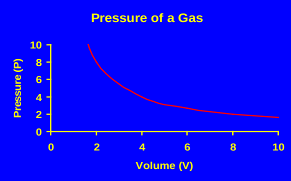


As variable T increases, so does variable V.

V = kT where k is a constant

Proportion

Inverse

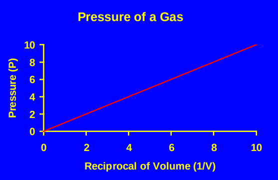


Variable V increases, but variable P decreases.

P = k/V where k is a constant

Proportion

Inverse



By plotting P against the reciprocal of V, we get the direct proportion graph.

Proportion

A 200 gallon tank is being filled at a constant rate. If it takes 20 minutes to fill the tank to a level of 60 gallons, how long will it take to fill the tank completely?

V = kt	V = 3t
60 = 20k	200 = 3t
k = 3	t = 67 mins

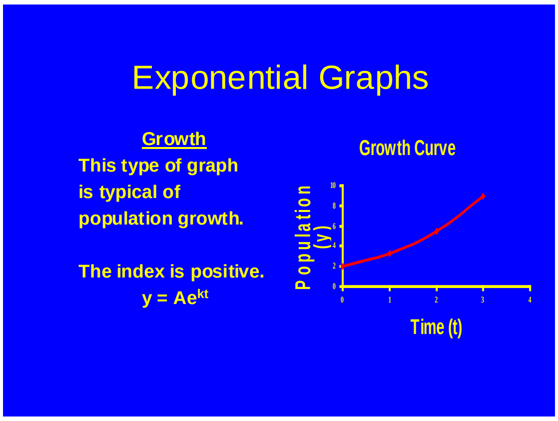
Proportion

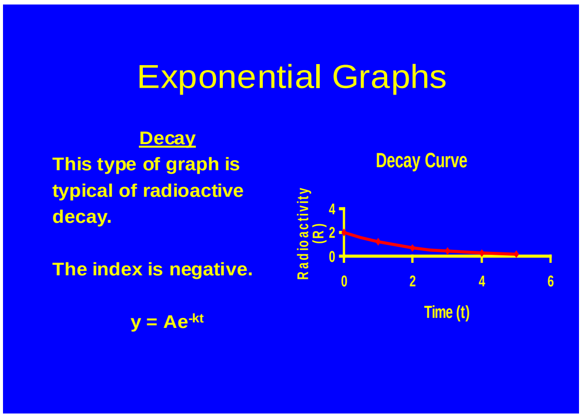
The velocity of an object is inversely proportional to the braking force. If v is 57 m /s when F is 5N, find the velocity when the braking force is 20N.

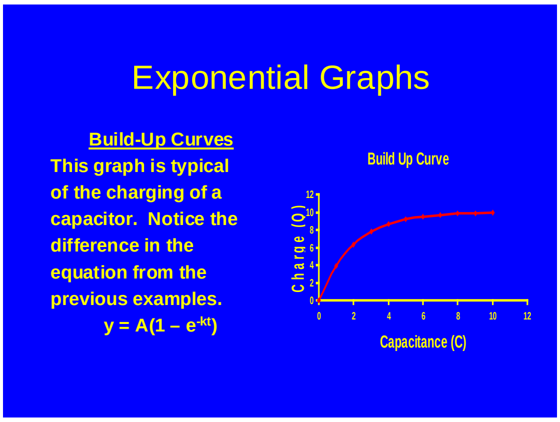
v = k/F	v = 285/F
57 = k/5	v = 285/20
k = 285	v = 14.25 m/s

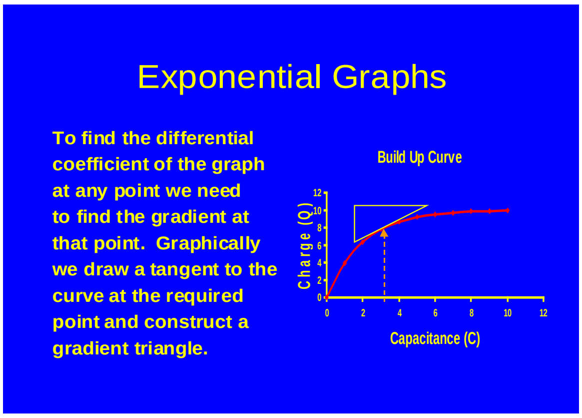
Applied Problems

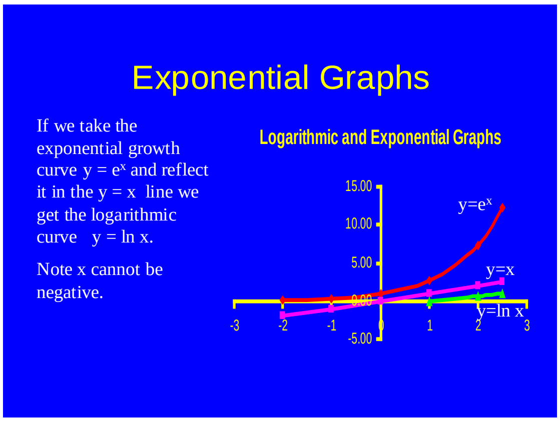
Exponential Graphs


Exponential Graphs
Growth
This type of graph is typical of population growth.
The index is positive.
y = Ae^kt
Growth Curve
Population (y)
Time (t)


Exponential Graphs
Decay
This type of graph is typical of radioactive decay.
The index is negative.
y = Ae^-kt
Decay Curve
Radioactivity (R)
Time (t)


Exponential Graphs
Build-Up Curves
This graph is typical of the charging of a capacitor. Notice the difference in the equation from the previous examples.
y = A(1 – e^-kt)
Build Up Curve
Charge (Q)
Capacitance (C)


Exponential Graphs
To find the differential coefficient of the graph at any point we need to find the gradient at that point. Graphically we draw a tangent to the curve at the required point and construct a gradient triangle.
Build Up Curve
Charge (Q)
Capacitance (C)


Exponential Graphs
If we take the exponential growth curve y = e^x and reflect it in the y = x line we get the logarithmic curve y = ln x.
Note x cannot be negative.
Logarithmic and Exponential Graphs
y=e^x
y=x
y=ln x

D QUESTIONNAIRE DATA TABLES

On the open response questions, the students sometimes gave more than one comment, and sometimes no response at all. This is reflected in the frequencies for each response. The total responses for each term vary, since the spring term data does not include the operations and maintenance groups because they were not in college at this time. This changes the maximum totals from 112 to 107 in 04/05 and 125 to 118 in 05/06. The actual response rates have been calculated in comparison to the maximum total, and the final figures were then calculated from the actual responses received, rather than the maximum totals. Not all of the questions would have needed to have been answered by all of the students, due to the filtering processes involved. The VLE users were separated out from non users for many of the questions. The maximum number of VLE users was 40 in 04/05 and 42 in 05/06. The total number of respondents is given for each of the questions for each of the terms. The response rate was generally highest in term 1 and lower in term 2 than in term 3. All of the tables give the 04/05 result in the first column of the tables and the 05/06 results in the second column. A dashed line indicates that the students were unavailable to respond because their course only took place during terms1 and 3, so they were not at college during the second term, whilst a shaded column indicates that the group did not exist. Any non-response from groups that did exist and were available is indicated by a zero score. Some of the students who were invited to respond did not take up the opportunity across all three of the terms.

Usage

Survey 2 Question 7(b) and Survey 3 Question 12
Have you heard about the mathematics lessons available on Blackboard? (Yes/No).

04/05 Total *N* = 112 Term 2 *N* = 89, Term 3 *N* = 103
05/06 Total *N* = 125 Term 2 *N* = 86, Term 3 *N* = 94

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	Yes	-	-	12	10	9	6		6	9	2	10	1		3	4	12	1		8	9	5	
	No	-	-	3	1	6	2		3	5	4	6	15		5	4	2	9		3	5	9	
Summer	Yes	2	3	10	6	8	1		4	6	1	8	2		0	6	3	5		7	8	7	
	No	3	4	4	9	4	6		6	4	5	5	13		10	1	9	2		2	4	5	

Response Rates: 04/05 96% Term 2, 79% Term 3; 05/06 73% Term 2, 75% Term 3

Table D.1: Awareness of Mathematics Resources

Survey 2 Question 7(c) and Survey 3 Question 13
Have you used or looked at the mathematics lessons available on Blackboard? (Yes/No). Please give reasons for your choice of answer:

04/05 Total N = 112 Term 2 N = 41, Term 3 N = 58
05/06 Total N = 125 Term 2 N = 90, Term 3 N = 84

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	Yes	-	-	1	6	7	6		4	1	0	3	0		1	0	8	0		0	8	0	
	No	-	-	12	5	6	2		5	2	6	9	16		7	0	6	0		0	6	0	
Summer	Yes	3	3	5	6	5	1		0	4	1	0	2		0	1	3	1		0	8	0	
	No	2	4	2	9	8	6		0	4	5	13	13		10	7	9	3		0	4	0	
Spring (Yes)	For extra support	-	-	1	2	1	2		0	0	0	0	0		0	1	4	0		0	3	0	
	To preview	-	-	0	0	1	0		1	0	0	0	0		0	0	1	0		0	3	0	
	For revision	-	-	0	1	1	1		2	0	0	0	0		0	0	1	0		0	1	0	
Spring (No)	Didn't know about it	-	-	2	0	1	0		2	1	1	6	3		3	0	1	0		0	1	0	
	I avoid computers	-	-	0	0	1	1		0	0	0	0	0		0	0	0	0		0	1	0	
	Not needed	-	-	1	1	1	1		2	0	0	1	1		2	0	1	0		0	2	0	
	No access	-	-	3	2	1	0		0	0	1	1	0		0	0	0	0		0	1	0	
	Apathy	-	-	1	1	3	0		0	1	1	1	0		0	0	1	0		0	1	0	
	Prefer to ask lecturer	-	-	0	0	0	0		0	0	0	0	0		0	0	1	0		0	0	0	
Summer (Yes)	For extra support	1	0	2	2	3	0		0	3	1	0	1		0	1	1	0		0	2	0	
	To preview	0	0	0	0	1	0		1	0	0	0	1		0	0	1	0		0	2	0	
	For revision	0	0	0	2	2	0		2	0	0	0	0		0	0	1	0		0	1	0	
Summer (No)	Didn't know about it	0	0	0	0	0	0		0	1	0	3	2		3	2	1	2		0	0	0	
	I avoid computers	0	0	0	0	0	1		0	0	0	0	0		0	0	0	0		0	0	0	
	Not needed	2	1	1	4	6	1		2	1	1	3	2		4	2	2	0		0	2	0	
	No access	0	0	0	1	0	0		0	0	1	0	2		0	0	0	0		0	0	0	
	Apathy	0	0	0	2	1	1		2	0	1	2	0		0	3	3	1		0	0	0	
	Prefer to ask lecturer	0	0	1	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	

Table D.2: Usage of Mathematics Resources

Survey 2 Question 12 and Survey 3 Question 5
How frequently have you used or looked at the mathematics lessons available on Blackboard?

04/05 Total *N* = 40
Term 2 *N* = 5, Term 3 *N* = 30
05/06 Total *N* = 42
Term 2 *N* = 30, Term 3 *N* = 42

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	Never	-	-	0	1	0	1		0	0	0	0	0		0	0	1	0		0	2	0	
	Occasionally	-	-	0	0	0	0		0	0	0	0	0		0	0	1	0		0	1	0	
	Often	-	-	1	3	4	3		2	0	0	0	0		0	0	5	0		0	4	0	
	Regularly	-	-	0	1	0	2		2	0	0	0	0		0	0	1	0		0	0	0	
Summer	Never	0	0	0	0	0	1		1	1	0	1	0		0	0	0	0		0	2	0	
	Occasionally	0	1	0	3	1	0		0	1	0	2	0		0	0	2	0		0	4	0	
	Often	2	5	6	7	7	3		7	3	3	4	3		0	2	7	0		0	4	0	
	Regularly	3	1	1	5	5	3		2	3	3	7	12		10	6	3	3		0	2	0	

Response Rates: 04/05 13% Term 2, 75% Term 3; 05/06 71% Term 2, 100% Term 3

Table D.3: Frequency of Use of Mathematics Resources

Survey 2 Question 9 and Survey 3 Question 6
How long (on average) do you spend looking at the mathematics lessons available on Blackboard when you access them?

04/05 Total *N* = 40
Term 2 *N* = 5, Term 3 *N* = 30
05/06 Total *N* = 42
Term 2 *N* = 30, Term 3 *N* = 42

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	I don't access them	-	-	0	0	0	1		0	0	0	0	0		0	0	1	0		0	1	0	
	Less than 5 minutes	-	-	0	2	1	0		0	0	0	0	0		0	0	1	0		0	1	0	
	Between 5 to 30 minutes	-	-	1	3	1	5		2	0	0	0	0		0	0	6	0		0	5	0	
	Between ½ to 1 hour	-	-	0	0	2	0		2	0	0	0	0		0	0	0	0		0	0	0	
	More than 1 hour	-	-	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Summer	I don't access them	0	0	0	0	0	1		0	0	0	0	0		0	0	0	0		0	2	0	
	Less than 5 minutes	1	0	0	3	1	0		0	2	0	1	0		0	0	1	0		0	2	0	
	Between 5 to 30 minutes	1	4	5	3	6	1		5	3	2	4	1		0	1	5	1		0	5	0	
	Between ½ to 1 hour	0	1	1	4	1	2		3	0	1	2	2		0	1	3	0		0	1	0	
	More than 1 hour	3	2	1	5	5	3		2	3	3	6	12		10	6	3	3		0	2	0	

Response Rates: 04/05 13% Term 2, 75% Term 3; 05/06 71% Term 2, 100% Term 3

Table D.4: Average Time Spent Using Mathematical Resources

Survey 1 Question 6(b), Survey 2 Question 10(b) and Survey 3 Question 15(b)
You indicated that (it would be useful to have a replay or review of previous mathematics lessons available so that the lesson could be looked at again at another time. Which of the following would you look at?) you have looked at or used the mathematics lessons on Blackboard. Which of the following have you replayed or reviewed at another time?

04/05 Total *N* = 112
Term 1 *N* = 93
Total *N* = 40
Term 2 *N* = 5, Term 3 *N* = 18
05/06 Total *N* = 125
Term 1 *N* = 106
Total *N* = 42
Term 2 *N* = 30, Term 3 *N* = 30

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Autumn	An individual lesson	1	3	2	6	3	0		6	0	1	3	2		3	1	3	1		0	4	0	
	Parts of an individual lesson	3	2	6	5	2	3		6	4	1	5	5		0	1	3	8		0	5	5	
	A complete set of lessons	2	1	3	5	2	1		4	3	4	2	2		3	3	2	2		0	6	3	
	Parts of a complete set of lessons	0	2	4	3	4	1		3	7	3	7	9		0	1	3	2		0	8	3	
	Background	0	3	0	2	0	2		3	0	2	0	3		1	0	6	0		0	6	0	
Spring	An individual lesson	-	-	0	2	1	1		3	0	0	0	0		0	0	2	0		0	3	0	
	Parts of an individual lesson	-	-	1	4	3	2		2	0	0	0	0		0	0	2	0		0	1	0	
	A complete set of lessons	-	-	1	4	0	2		2	0	0	0	0		0	0	2	0		0	5	0	
	Parts of a complete set of lessons	-	-	0	2	1	0		2	0	0	0	0		0	0	2	0		0	2	0	
	Background	-	-	0	1	0	0		2	0	0	0	0		0	0	3	0		0	4	0	
Summer	An individual lesson	0	0	1	2	3	0		2	0	0	0	1		0	0	0	1		0	4	0	
	Parts of an individual lesson	1	0	1	2	3	0		2	3	1	0	1		0	0	2	0		0	2	0	
	A complete set of lessons	0	1	2	0	0	0		2	1	0	0	0		0	1	0	0		0	4	0	
	Parts of a complete set of lessons	1	0	0	0	1	0		2	0	0	0	0		0	0	2	0		0	3	0	
	Background	0	1	0	2	0	1		0	0	0	0	0		0	0	1	0		0	2	0	

Response Rates: 04/05 83% Term 1, 13% Term 2, 45% Term 3; 05/06 85% Term 1, 71% Term 2, 71% Term 3

Table D.5: Review Areas for the Mathematical Resource

Survey 1 Question 6(c), Survey 2 Question 10(c),10(d) and Survey 3 Question 15(c)
You indicated that (it would be useful to have a replay or review of previous mathematics lessons available so that the lesson could be looked at again at another time. Why would you look at these?) you have used the mathematics lessons on Blackboard. Why did you replay or review the mathematics lesson at another time? Looking at your answers, which was the main reason?

04/05 Total *N* = 112
Term 1 *N* = 93
Total *N* = 40
Term 2 N = 5, Term 3 *N* = 18
05/06 Total *N* = 125
Term 1 *N* = 106
Total *N* = 42
Term 2 *N* = 30, Term 3 *N* = 30

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Autumn	To cover work I had missed	3	0	5	7	5	1		4	0	3	2	2		3	1	2	0		4	9	6	
	To cover work I didn't understand	4	4	7	10	8	1		5	8	3	8	4		2	3	6	0		8	10	7	
	To remind me of basic underlying techniques	2	3	8	8	4	4		3	6	5	8	6		5	5	9	0		7	6	5	
	To revise for exams	3	3	7	10	5	1		7	6	3	6	10		5	3	4	0		7	10	7	
	Other	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	1	0	
Spring	To cover work I had missed	-	-	1	0	0	2		1	0	0	0	0		0	0	4	0		0	5	0	
	To cover work I didn't understand	-	-	1	2	1	1		1	0	0	0	0		0	0	6	0		0	6	0	
	To remind me of basic underlying techniques	-	-	1	4	3	1		2	0	0	0	0		0	0	3	0		0	2	0	
	To revise for exams	-	-	1	3	4	2		2	0	0	0	0		0	0	3	0		0	4	0	
	Out of curiosity	-	-	0	0	0	0		1	0	0	0	0		0	0	0	0		0	1	0	
	Other	-	-	0	0	0	0		0	0	0	0	0		0	0	0	0		0	1	0	
Summer	To cover work I had missed	1	0	1	0	2	0		0	0	0	0	0		0	0	0	1		0	0	0	
	To cover work I didn't understand	0	0	1	0	2	0		0	2	0	0	0		0	0	0	0		0	0	0	
	To remind me of basic underlying techniques	0	0	2	2	2	0		1	1	0	0	0		0	1	2	0		0	1	0	
	To revise for exams	0	0	2	2	2	0		3	1	0	0	2		0	0	1	0		0	5	0	
	Out of curiosity	1	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	

Response Rates: 04/05 83% Term 1, 13% Term 2, 45% Term 3; 05/06 85% Term 1, 71% Term 2, 71% Term 3

Table D.6: Reasons for Reviewing the Mathematical Resource

Survey 2 Question 10(f) and Survey 3 Question 17 *What lesson(s) did you replay? Which mathematics lessons did you access from Blackboard?*																									
04/05 Total *N* = 40 Term 2 *N* = 5, Term 3 *N* = 18 05/06 Total *N* = 42 Term 2 *N* = 30, Term 3 *N* = 30		Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)			
Term Time	**Category**																								
Spring	Powers & indices	-	-	1	3	1	0		2	0	0	0	0		0	0	2	0		0	2	0			
	Simplifying expressions	-	-	1	2	0	0		1	0	0	0	0		0	0	2	0		0	2	0			
	Solving equations	-	-	1	1	0	2		1	0	0	0	0		0	0	2	0		0	2	0			
	Transpositions	-	-	0	2	0	1		1	0	0	0	0		0	0	3	0		0	4	0			
	Simultaneous equations	-	-	1	2	1	2		1	0	0	0	0		0	0	3	0		0	1	0			
	Surface areas	-	-	1	0	1	1		1	0	0	0	0		0	0	1	0		0	3	0			
	Volumes	-	-	1	0	2	3		1	0	0	0	0		0	0	1	0		0	4	0			
	Trigonometry & Pythagoras	-	-	0	0	0	0		1	0	0	0	0		0	0	3	0		0	3	0			
	Circular Measure	-	-	0	0	1	0		2	0	0	0	0		0	0	1	0		0	2	0			
	Algebraic graphs	-	-	0	1	0	3		2	0	0	0	0		0	0	4	0		0	1	0			
	Simultaneous graphs	-	-	0	2	1	1		2	0	0	0	0		0	0	4	0		0	3	0			
	Trigonometric graphs	-	-	0	2	0	1		2	0	0	0	0		0	0	4	0		0	1	0			
	Waveforms	-	-	0	2	0	2		2	0	0	0	0		0	0	3	0		0	1	0			
	Statistical diagrams	-	-	0	0	0	1		1	0	0	0	0		0	0	4	0		0	1	0			
	Averages	-	-	0	0	0	0		1	0	0	0	0		0	0	3	0		0	2	0			
	Dispersion	-	-	0	0	0	1		1	0	0	0	0		0	0	3	0		0	1	0			
Response Rates: 04/05 13% Term 2; 05/06 71% Term 2																									

Table D.7: Mathematical Resource Lessons Accessed Through the VLE (Spring)

Survey 2 Question 10(f) and Survey 3 Question 17
What lesson(s) did you replay? Which mathematics lessons did you access from Blackboard?

04/05 Total *N* = 40
Term 2 *N* = 5, Term 3 *N* = 18
05/06 Total *N* = 42
Term 2 *N* = 30, Term 3 *N* = 30

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Summer	Powers & indices	2	3	1	2	1	0		0	2	0	0	0		0	0	2	0		0	4	0	
	Simplifying expressions	2	0	1	1	1	0		0	1	0	0	0		0	1	2	1		0	3	0	
	Solving equations	2	0	0	2	1	1		2	1	0	0	0		0	1	2	0		0	3	0	
	Transpositions	2	0	2	1	0	0		1	3	0	0	0		0	0	1	0		0	4	0	
	Simultaneous equations	2	0	1	1	0	0		0	1	0	0	0		0	0	2	0		0	5	0	
	Surface areas	2	0	0	1	1	0		0	1	0	0	0		0	0	1	0		0	6	0	
	Volumes	2	1	1	1	1	0		0	1	0	0	0		0	0	1	0		0	7	0	
	Trigonometry & Pythagoras	2	0	1	1	1	0		0	3	0	0	0		0	1	2	0		0	7	0	
	Circular Measure	2	0	1	0	1	0		2	1	0	0	0		0	0	1	0		0	5	0	
	Algebraic graphs	2	0	0	1	1	0		0	1	0	0	0		0	0	1	0		0	3	0	
	Simultaneous graphs	2	0	1	1	0	0		2	1	1	0	0		0	0	2	0		0	4	0	
	Trigonometric graphs	2	0	0	1	1	0		1	1	0	0	0		0	0	1	0		0	5	0	
	Waveforms	2	0	0	1	0	0		1	1	0	0	0		0	0	1	0		0	4	0	
	Statistical diagrams	2	0	2	0	2	0		2	1	0	0	0		0	0	0	0		0	5	0	
	Averages	2	0	2	0	2	0		2	1	0	0	0		0	0	1	0		0	5	0	
	Dispersion	2	0	2	0	1	0		3	1	0	0	1		0	0	1	0		0	4	0	
	Polynomial differentiation	2	0	1	3	0	0		2	1	0	0	0		0	0	1	0		0	4	0	
	Exponential differentiation	2	1	1	2	0	1		2	1	0	0	0		0	0	1	0		0	4	0	
	Trigonometric differentiation	2	1	1	3	1	0		2	1	1	0	0		0	1	1	0		0	4	0	
	Differential applications	3	0	2	1	0	0		2	1	0	0	1		0	0	1	0		0	6	0	
	Definite & indefinite integration	3	0	1	0	1	0		1	1	0	0	1		0	0	1	0		0	5	0	
	Area under a curve & differential equations	2	0	1	0	0	0		2	1	0	0	0		0	0	1	0		0	4	0	
	Sine & cosine rules	2	0	0	0	1	0		0	1	0	0	1		0	0	0	0		0	5	0	
	Vectors	2	0	0	0	0	1		1	1	0	0	0		0	0	0	0		0	3	0	
	Algebraic solution of quadratic equations	2	0	0	0	0	0		0	1	0	0	0		0	0	0	0		0	4	0	
	Proportion & exponential graphs	2	0	1	0	0	0		1	1	0	0	0		0	0	0	0		0	4	0	

Response Rates: 04/05 45% Term 3; 05/06 71% Term 3

Table D.8: Mathematical Resource Lessons Accessed Through the VLE (Summer)

Viability

<table>
<tr><td colspan="24">Survey 1 Question 18, Survey 2 Question 6 and Survey 3 Question 24
Do you think it is possible to learn mathematics via the Internet? (Yes/No/Don't Know). Please give reasons for your choice of answer:</td></tr>
<tr><td colspan="2">04/05 Total N = 112 Term 1 N = 93, Term 2 N = 44, Term 3 N = 38 05/06 Total N = 125 Term 1 N = 106, Term 2 N = 85, Term 3 N = 66</td><td colspan="2" rowspan="2">Operations & Maintenance (PT)</td><td colspan="2" rowspan="2">Electrical & Electronic Group A (PT)</td><td colspan="2" rowspan="2">Electrical & Electronic Group B (PT)</td><td colspan="2" rowspan="2">Electrical & Electronic Group C (PT)</td><td colspan="2" rowspan="2">Mechanical Group A (PT)</td><td colspan="2" rowspan="2">Mechanical Group B (PT)</td><td colspan="2" rowspan="2">Mechanical Group C (PT)</td><td colspan="2" rowspan="2">Manufacturing Group A (FT)</td><td colspan="2" rowspan="2">Manufacturing Group B (FT)</td><td colspan="2" rowspan="2">Telecommunications (FT)</td><td colspan="2" rowspan="2">Fabricators (PT)</td></tr>
<tr><td>Term Time</td><td>Category</td></tr>
<tr><td rowspan="3">Autumn</td><td>Yes</td><td>2</td><td>0</td><td>5</td><td>5</td><td>3</td><td>1</td><td></td><td>3</td><td>7</td><td>2</td><td>6</td><td>3</td><td></td><td>4</td><td>4</td><td>9</td><td>0</td><td></td><td>4</td><td>10</td><td>4</td><td></td></tr>
<tr><td>No</td><td>3</td><td>4</td><td>8</td><td>4</td><td>8</td><td>4</td><td></td><td>3</td><td>6</td><td>2</td><td>8</td><td>7</td><td></td><td>1</td><td>3</td><td>2</td><td>0</td><td></td><td>7</td><td>0</td><td>9</td><td></td></tr>
<tr><td>Don't know</td><td>0</td><td>2</td><td>2</td><td>6</td><td>0</td><td>3</td><td></td><td>4</td><td>1</td><td>4</td><td>1</td><td>6</td><td></td><td>7</td><td>0</td><td>4</td><td>0</td><td></td><td>2</td><td>6</td><td>0</td><td></td></tr>
<tr><td rowspan="3">Spring</td><td>Yes</td><td>-</td><td>-</td><td>5</td><td>5</td><td>11</td><td>4</td><td></td><td>3</td><td>3</td><td>3</td><td>2</td><td>3</td><td></td><td>2</td><td>0</td><td>8</td><td>0</td><td></td><td>0</td><td>8</td><td>0</td><td></td></tr>
<tr><td>No</td><td>-</td><td>-</td><td>7</td><td>3</td><td>2</td><td>2</td><td></td><td>2</td><td>1</td><td>1</td><td>10</td><td>6</td><td></td><td>4</td><td>0</td><td>3</td><td>0</td><td></td><td>0</td><td>2</td><td>0</td><td></td></tr>
<tr><td>Don't know</td><td>-</td><td>-</td><td>3</td><td>3</td><td>0</td><td>2</td><td></td><td>4</td><td>0</td><td>2</td><td>0</td><td>7</td><td></td><td>2</td><td>0</td><td>2</td><td>0</td><td></td><td>0</td><td>4</td><td>0</td><td></td></tr>
<tr><td rowspan="3">Summer</td><td>Yes</td><td>1</td><td>0</td><td>0</td><td>5</td><td>5</td><td>3</td><td></td><td>5</td><td>4</td><td>3</td><td>8</td><td>6</td><td></td><td>6</td><td>3</td><td>7</td><td>1</td><td></td><td>0</td><td>3</td><td>0</td><td></td></tr>
<tr><td>No</td><td>1</td><td>4</td><td>1</td><td>4</td><td>3</td><td>3</td><td></td><td>1</td><td>0</td><td>2</td><td>5</td><td>6</td><td></td><td>4</td><td>4</td><td>2</td><td>2</td><td></td><td>0</td><td>0</td><td>0</td><td></td></tr>
<tr><td>Don't know</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td></td><td>0</td><td>1</td><td>0</td><td></td></tr>
<tr><td colspan="24">Response Rates: 04/05 83% Term 1, 41% Term 2, 34% Term 3; 05/06 85% Term 1, 72% Term 2, 53% Term 3</td></tr>
</table>

Table D.9: Viability of Internet Resources (Opinions)

Survey 1 Question 18, Survey 2 Question 6 and Survey 3 Question 24

Do you think it is possible to learn mathematics via the Internet? (Yes/No/Don't Know). Please give reasons for your choice of answer:

04/05 Total *N* = 112 Term 1 *N* = 93, Term 2 *N* = 44, Term 3 *N* = 38
05/06 Total *N* = 125 Term 1 *N* = 106, Term 2 *N* = 85, Term 3 *N* = 66

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Autumn (Yes)	Revision	0	0	1	1	0	0		0	1	0	0	0		0	0	0	0		1	8	0	
	Different explanation	1	0	1	2	2	1		0	2	2	3	1		0	1	1	0		0	0	1	
	Past experience	0	0	1	3	1	0		0	1	0	0	1		0	3	6	0		0	0	1	
	Own pace	0	0	0	0	0	0		0	0	0	0	0		1	0	2	0		0	1	0	
	Easy to access/use	0	0	2	0	0	0		3	3	0	0	0		0	0	0	0		1	2	0	
Autumn (No)	Insufficient depth	0	2	0	2	3	0		3	0	0	0	1		1	0	0	0		1	0	0	
	No support	1	3	2	2	1	1		1	0	1	1	3		0	0	0	0		2	0	1	
	Distracted	0	0	0	0	0	1		0	3	1	1	1		0	2	1	0		0	0	1	
	No access to internet	0	0	1	0	2	0		0	0	0	1	0		0	0	0	0		0	0	0	
	Prefer books	0	0	0	0	0	1		0	0	0	0	0		0	0	1	0		0	0	0	
	Lack of ICT skills	0	0	0	0	0	1		0	0	0	0	0		0	0	0	0		0	0	0	
Autumn (DK)	No interaction	1	0	3	0	3	0		0	1	0	3	2		1	1	0	0		4	0	4	
	Never tried	0	1	2	2	0	2		3	0	0	1	4		3	0	2	0		3	3	1	
	Depends	1	1	0	1	1	0		0	1	0	2	0		0	0	1	0		0	2	0	
Spring (Yes)	Revision	-	-	1	1	2	0		0	0	0	1	0		0	0	0	0		0	2	0	
	Different explanation	-	-	2	2	0	2		0	1	2	1	1		2	0	2	0		0	3	0	
	Past experience	-	-	0	0	1	1		3	1	0	0	1		0	0	4	0		0	2	0	
	Own pace	-	-	0	1	0	0		0	0	0	0	0		0	0	2	0		0	2	0	
	Easy to access/use	-	-	0	1	1	0		0	0	1	0	1		0	0	0	0		0	1	0	
Spring (No)	Insufficient depth	-	-	0	1	2	1		0	0	0	1	0		0	0	1	0		0	0	0	
	No support	-	-	2	1	2	2		1	1	0	0	2		2	0	3	0		0	0	0	
	Distracted	-	-	0	1	0	0		0	0	1	1	0		1	0	0	0		0	0	0	
Spring (DK)	No interaction	-	-	5	0	1	1		1	1	1	7	2		1	0	0	0		0	1	0	
	Never tried	-	-	3	2	0	0		2	0	0	1	4		2	0	2	0		0	2	0	
	Depends	-	-	0	1	1	0		1	1	0	0	1		0	0	0	0		0	1	0	
Summer (Yes)	Revision	0	0	0	0	1	0		0	0	0	0	0		1	1	0	0		0	0	0	
	Different explanation	0	0	0	2	0	0		2	1	3	2	3		2	0	4	0		0	2	0	
	Past experience	0	0	0	0	0	0		0	1	0	1	2		1	1	2	1		0	1	0	
	Own pace	0	0	0	1	0	0		0	0	0	0	0		0	1	1	0		0	0	0	
	Easy to access/use	0	0	0	1	0	0		0	0	0	1	0		0	0	0	0		0	1	0	
Summer (No)	Insufficient depth	1	0	0	1	1	1		0	0	0	0	0		1	1	0	0		0	0	0	
	No support	0	0	0	2	0	1		0	2	2	2	2		2	0	0	0		0	0	0	
	Distracted	0	0	0	0	0	0		0	0	0	1	0		0	1	0	0		0	0	0	
Summer (DK)	No interaction	1	0	0	0	4	1		0	1	1	3	4		0	2	2	0		0	0	0	
	Never tried	0	0	0	0	0	0		0	0	0	0	0		0	0	0	1		0	1	0	
	Depends	1	0	0	0	1	0		0	0	0	1	1		0	0	0	0		0	0	0	

Table D.10: Viability of Internet Resources (Reasons)

Survey 3 Question 18
Do you think it is possible to learn mathematics by using the mathematics lessons available on Blackboard? (Yes/No). Please give reasons for your choice of answer:

04/05 Total *N* = 40 **Term 3 *N* = 18** **05/06 Total *N* = 42** **Term 3 *N* = 37**		Operations & Maintenance (PT)		Electrical & Electronic		Electrical & Electronic Group B (PT)		Electrical & Electronic		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term Time	**Category**																						
Summer	Yes	1	1	3	6	2	1		2	3	1	0	1		0	0	1	1		0	6	0	
	No	1	2	2	0	3	0		2	1	0	0	1		0	1	2	0		0	2	0	
Summer (Yes)	Refresher or recap	1	0	0	3	2	0		1	1	0	0	0		1	0	0	0		0	1	0	
	Easy to understand	1	0	1	0	2	0		0	1	0	0	1		0	0	1	0		0	2	0	
Summer (No)	Need lecturer	1	0	0	0	1	0		1	1	0	0	1		0	0	0	0		0	1	0	
Response Rates: 04/05 45% Term 3; 05/06 64% Term 3																							

Table D.11: Viability of VLE Resources

Survey 1 Question 20 and Survey 2 Question 7(a)
(If) Mathematics work, specifically written for your course, (were) is available over the Internet (,). Would you be inclined to use it?

04/05 Total *N* = 112 **Term 1 *N* = 95** **Total *N* = 107** **Term 2 *N* = 44** **05/06 Total *N* = 125** **Term 1 *N* = 99** **Total *N* = 118** **Term 2 *N* = 95**		Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term Time	**Category**																						
Autumn	Not at all	1	2	3	9	2	1		1	4	6	4	6		4	1	4	0		3	0	3	
	Reluctantly	3	3	7	6	4	6		6	7	3	8	8		5	4	8	0		6	5	6	
	Sometimes	1	1	3	0	4	0		2	0	1	3	1		2	1	2	0		3	0	1	
	Definitely	0	1	2	0	1	1		1	3	0	1	1		1	1	1	0		1	1	4	
Spring	Not at all	-	-	2	2	1	1		1	1	2	1	3		1	0	3	0		0	6	0	
	Reluctantly	-	-	6	5	11	4		5	1	3	7	6		6	0	9	0		0	8	0	
	Sometimes	-	-	4	4	0	1		1	0	1	3	4		1	0	1	0		0	0	0	
	Definitely	-	-	3	0	1	2		1	2	0	1	3		0	0	1	0		0	0	0	
Response Rates: 04/05 85% Term 1, 41% Term 2; 05/06 79% Term 1, 81% Term 2																							

Table D.12: Viability of a Specific Mathematical Resource

Survey 1 Question 19 and Survey 3 Question 23 *When (If) you need to practice some mathematics topics, which of the following would you use?*																							
04/05 Total *N* = 112 Term 1 *N* = 95, Term 3 *N* = 38 05/06 Total *N* = 125 Term 1 *N* = 99, Term 3 *N* = 66		Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term Time	**Category**																						
Autumn	Text books	5	0	9	7	6	3		5	7	4	6	6		3	3	4	0		10	6	4	
	Internet	3	0	4	5	2	0		1	4	2	6	5		1	2	8	0		5	8	3	
	Work sheets	4	4	13	14	8	2		4	12	6	11	13		8	5	7	0		10	11	8	
	Revision sheets	4	6	14	12	8	3		5	10	6	10	13		5	3	8	0		8	10	9	
	Class notes	5	6	12	13	9	7		10	13	8	15	15		12	7	9	0		10	15	11	
	Ask someone to help	3	2	6	3	3	0		2	6	2	5	7		2	2	7	0		5	6	5	
Summer	Text Books	2	2	1	4	5	3		2	2	3	8	6		6	2	1	1		0	1	0	
	Internet	1	1	0	3	4	1		2	1	4	6	2		1	3	4	1		0	1	0	
	Work sheets	2	1	0	5	3	2		3	3	3	12	7		5	4	5	3		0	2	0	
	Revision sheets	2	3	1	8	5	3		4	3	3	10	9		10	6	5	3		0	1	0	
	Class notes	2	3	1	5	7	5		3	3	5	10	10		9	6	6	3		0	2	0	
	Ask someone to help	2	1	1	5	5	1		1	2	1	7	6		1	4	2	3		0	2	0	
Response Rates: 04/05 85% Term 1, 34% Term 3; 05/06 79% Term 1, 53% Term 3																							

Table D.13: Preferred Practice Methods for Mathematic

Survey 2 Question 11(a) and Survey 3 Question 14(a) *From where did you access the mathematics lessons on Blackboard?*																							
04/05 Total *N* = 40 Term 2 *N* = 5, Term 3 *N* = 18 05/06 Total *N* = 42 Term 2 *N* = 30, Term 3 *N* = 30		Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term Time	**Category**																						
Spring	College	-	-	1	1	3	4		4	0	0	0	0		0	0	8	0		0	3	0	
	Home	-	-	1	5	1	2		1	0	0	0	0		0	0	3	0		0	4	0	
	Workplace	-	-	1	1	4	0		1	0	0	0	0		0	0	0	0		0	0	0	
	Other	-	-	0	0	0	0		0	0	0	0	0		0	0	1	0		0	0	0	
Summer	College	3	2	5	3	5	1		4	4	1	0	2		0	1	3	1		0	6	0	
	Home	0	2	1	6	2	0		2	2	0	0	0		0	0	2	0		0	5	0	
	Workplace	0	0	0	1	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Other	0	3	0	6	0	1		4	0	1	0	2		0	0	3	0		0	8	0	

Table D.14: Mathematical Resource Access Locations

Survey 2 Question 11(b) and Survey 3 Question 14(b)
What factors affected where you accessed the mathematics lessons on Blackboard?

04/05 Total *N* = 40
Term 2 *N* = 5, Term 3 *N* = 18
05/06 Total *N* = 42
Term 2 *N* = 30, Term 3 *N* = 30

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	Computer availability	-	-	1	3	2	1		2	0	0	0	0		0	0	5	0		0	1	0	
	Access costs	-	-	0	0	1	0		1	0	0	0	0		0	0	0	0		0	1	0	
	Time factors	-	-	0	3	3	3		3	0	0	0	0		0	0	3	0		0	4	0	
	Other	-	-	0	0	0	0		0	1	0	0	0		0	0	0	0		0	0	0	
Summer	Computer availability	2	2	2	3	4	1		4	3	0	0	1		0	0	0	1		0	1	0	
	Access costs	0	0	1	1	0	0		1	0	0	0	0		0	0	1	0		0	0	0	
	Time factors	0	0	2	4	3	0		2	2	1	0	1		0	1	3	1		0	7	0	
	Other	1	1	1	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	

Response Rates: 04/05 13% Term 2, 71% Term 3; 05/06 45% Term 2, 71% Term 3

Table D.15: Factors Affecting Access of Mathematical Resources

Survey 2 Question 16 and Survey 3 Question 7
What types of mathematics support would you prefer?

04/05 Total *N* = 107
Term 2 *N* = 40
Total *N* = 112
Term 3 *N* = 38
05/06 Total *N* = 118
Term 2 *N* = 95
Total *N* = 125
Term 3 *N* = 66

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	Internet resources	-	-	1	4	3	2		3	1	1	5	3		0	0	5	0		0	5	0	
	Individual tuition	-	-	7	4	3	3		5	2	4	4	8		3	0	4	0		0	3	0	
	Extra group work sessions	-	-	6	7	2	1		4	1	3	3	8		2	0	4	0		0	5	0	
	Other	-	-	0	0	1	1		1	0	0	0	2		2	0	0	0		0	0	0	
Summer	Internet resources	1	0	2	4	3	0		2	3	1	2	2		2	0	2	0		0	2	0	
	Lessons & notes posted on Blackboard	1	1	2	4	4	0		2	3	3	2	1		1	1	2	0		0	3	0	
	Individual tuition	3	5	4	7	6	4		4	5	2	10	4		4	2	8	4		0	2	0	
	Extra group work sessions	1	2	2	5	5	1		5	2	2	2	4		4	4	2	1		0	3	0	
	Other	1	0	0	0	0	2		1	0	1	0	0		0	1	1	0		0	1	0	

Response Rates: 04/05 41% Term 2, 34% Term 3; 05/06 81% Term 2, 53% Term 3

Table D.16: Preferred Methods of Mathematical Support

Learners Experience

Survey 1 Question 5:
Please explain below what you would do when you found a topic area in mathematics difficult to understand: ……….

04/05 Total *N* = 112
05/06 Total *N* = 125

Main Heading	Sub Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Do Nothing		0	0	0	0	1	1		0	0	0	0	0		0	0	0	0		0	2	2	
New Explanation	General	0	2	2	2	1	1		3	0	1	2	3		1	2	1	0		1	2	3	
	Simpler	0	0	0	0	0	0		0	0	0	0	0		0	0	1	0		0	0	0	
	In Depth	0	0	0	0	0	0		0	0	0	0	0		0	0	1	0		0	0	1	
Review Research	General	2	1	2	1	1	1		0	2	1	3	3		2	2	3	1		3	1	0	
	Books	1	0	0	0	2	1		0	2	1	1	1		0	0	0	0		1	1	1	
	Internet	1	0	2	0	0	0		0	0	1	2	0		0	0	0	0		0	2	0	
Seek Help Support	General	1	2	2	2	3	1		2	2	2	8	4		2	1	1	0		4	3	4	
	Parents	0	0	0	0	0	0		0	1	0	1	0		0	0	1	0		0	1	0	
	Lecturer etc	3	2	11	2	8	6		8	11	4	4	11		9	3	10	2		8	8	6	
	Friend etc	1	0	1	0	1	1		1	4	1	4	1		1	0	1	1		5	4	1	

Table D.17: Categorised Open Support Choices

Survey 2 Question 13(b) and Survey 3 Question 22(b):
How could the mathematics lessons on Blackboard be improved?

04/05 Total *N* = 40
Term 2 *N* = 9, Term 3 *N* = 22
05/06 Total *N* = 42
Term 2 *N* = 7, Term 3 *N* = 13

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	None needed	-	-	0	3	1	2		1	0	0	0	0		0	0	1	0		0	2	0	
	More exam style questions	-	-	0	0	1	0		0	0	0	0	0		0	1	1	0		0	0	0	
	Regular e-updates	-	-	0	0	0	0		0	0	0	0	0		0	1	1	0		0	0	0	
	Assignments uploaded	-	-	0	1	0	0		0	0	0	0	0		0	1	1	0		0	0	0	
	Linked Q & A	-	-	0	0	0	0		0	0	0	0	0		0	1	1	0		0	0	0	
	More detail and depth	-	-	0	0	0	1		0	0	0	0	0		0	1	2	0		0	0	0	
	More accessible to all	-	-	0	0	0	1		0	0	0	0	0		0	1	1	0		0	0	0	
	Video lessons	-	-	0	0	0	0		0	0	0	0	0		0	0	0	0		0	1	0	
	More interactive	-	-	0	0	0	0		2	0	0	0	0		0	0	0	0		0	0	0	
Summer	None needed	0	0	1	2	1	0		0	1	0	0	0		0	0	0	1		0	0	0	
	Video/Voice- over	1	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	1	0	
	Easier access to VLE	0	0	0	0	1	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Available from induction	0	0	0	0	0	0		0	1	0	0	0		0	0	0	0		0	0	0	
	All staff supporting its use	0	0	0	0	0	0		0	0	0	0	0		0	1	0	0		0	0	0	
	More detail and depth	0	1	0	1	0	0		1	0	0	0	0		0	0	1	0		0	2	0	
	More interactive	0	0	0	1	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Chat/Open post	0	0	0	0	0	0		0	0	0	0	0		0	0	1	0		0	0	0	

Response Rates: 04/05 23% Term 2, 53% Term 3; 05/06 52% Term 2, 31% Term 3

Table D.18: Categorised Open Improvement Choices

Survey 3 Question 21: *What do you feel are the benefits and problems associated with the mathematics lessons available on Blackboard?*		
04/05	**Benefits**	**Problems**
Operations & Maintenance	Useful revision resource	You need a basic understanding to look at it
Electrical & Electronic Group A	Different explanations Can take your own time, learn at leisure, not under pressure	Understanding the work No teacher to explain in another way if you don't understand
Electrical & Electronic Group B	Good support for revision Provides extra support to help with understanding Good clear layout. Possible to look at subjects in my own time Great for information	Problems with passwords at start of course Access – password problems throughout course Not always explanatory! Can not always access it as I do not have my own computer
Mechanical Group A	Allows you to learn when you want. Allows you to go over what you want Good for learning	Depends on computer availability in college as I can not access internet from home or work
Manufacturing Group B	Catch up if I've missed a lesson	I don't have the internet
05/06	**Benefits**	**Problems**
Operations & Maintenance	Have equations in front of you	
Electrical & Electronic Group A	Gives you help Do at own time and pace Learn in your own time Available all hours	Some PowerPoint presentations you can't blow up into a full screen No personal support if you cannot understand Access to VLE and computers
Electrical & Electronic Group C	It is always there for support To recap on things Can look at any time	Can not access it from everywhere Computers can be slow to connect Not in enough depth
Mechanical Group B	Easy access for further study	
Manufacturing	Revision	No lecturer near to help
Telecommunications	Good written material Easy access. Availability at any time. Complementary with lesson Helps understand the lessons. Makes test easier to pass	Not actually lessons could be video lessons with notes. This would be easier to do Sometimes need more details Time

Table D.19: Open Choices of Benefits and Problems

Survey 2 Question 8 and Survey 3 Question 14(c)
Was it easy to find the mathematics lessons you wanted on Blackboard? (Yes/No). Please give reasons for your choice of answer:

04/05 Total *N* = 40
Term 2 *N* = 5, Term 3 *N* = 30
05/06 Total *N* = 42
Term 2 *N* = 18, Term 3 *N* = 30

Term Time	**Category**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	Yes	-	-	1	5	3	5		4	0	0	0	0		0	0	8	0		0	7	0	
	No	-	-	0	0	1	1		0	0	0	0	0		0	0	0	0		0	0	0	
Summer	Yes	3	3	5	6	5	5		1	4	0	0	2		0	0	4	1		0	7	0	
	No	0	0	0	0	0	0		0	0	1	0	0		0	0	0	0		0	1	0	
Response Rates: 04/05 13% Term 2, 45% Term 3; 05/06 70% Term 2, 70% Term 3																							
Spring (Yes)	Good layout	-	-	1	1	1	0		2	0	0	0	0		0	0	5	0		0	2	0	
	Easy access	-	-	0	1	0	1		2	0	0	0	0		0	0	1	0		0	0	0	
	User friendly	-	-	0	1	0	1		0	0	0	0	0		0	0	1	0		0	4	0	
Spring (No)	Poor access	-	-	0	0	1	1		0	1	0	0	0		0	0	0	0		0	0	0	
Summer (Yes)	Good layout	0	0	0	2	2	0		1	2	0	0	1		0	0	0	0		0	1	0	
	Easy access	0	0	2	0	1	0		1	0	0	1	1		0	0	0	0		0	2	0	
	User friendly	0	0	0	0	1	0		0	0	0	0	0		0	0	0	0		0	0	0	
Summer (No)	Poor access	0	0	0	0	0	0		0	0	1	0	0		0	0	1	0		0	0	0	

Table D.20: User Friendliness of VLE and Mathematics Resources

Survey 2 Question 10(e) and Survey 3 Question 15(d)
Have the mathematics lessons on Blackboard made it easier to keep up with mathematics work? (Yes/No). Please give reasons for your choice of answer:

04/05 Total *N* = 40
Term 2 *N* = 4, Term 3 *N* = 29
05/06 Total *N* = 42
Term 2 *N* = 17, Term 3 *N* = 28

Term Time	**Category**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	Yes	-	-	1	4	2	3		2	0	0	0	0		0	0	8	0		0	6	0	
	No	-	-	0	1	1	3		2	0	0	0	0		0	0	0	0		0	0	0	
Summer	Yes	1	2	3	6	4	1		3	3	1	0	1		0	1	2	1		0	8	0	
	No	1	1	1	0	1	0		1	1	0	0	1		0	0	1	0		0	0	0	
Response Rates: 04/05 10% Term 2, 43% Term 3; 05/06 69% Term 2, 66% Term 3																							
Spring (Yes)	Revision purposes	-	-	0	0	0	0		0	0	0	0	0		0	0	2	0		0	0	0	
	Different explanation	-	-	0	0	0	0		2	0	0	0	0		0	0	1	0		0	2	0	
	Extra support	-	-	1	1	0	1		0	0	0	0	0		0	0	3	0		0	3	0	
Spring (No)	Too straight forward	-	-	0	1	0	2		1	0	0	0	0		0	0	0	0		0	0	0	
Summer (Yes)	Revision purposes	1	0	0	1	1	0		0	0	0	0	0		0	0	0	0		0	2	0	
	Different explanation	0	0	0	0	1	0		1	1	1	0	0		0	0	1	0		0	1	0	
	Extra support	0	0	0	1	1	0		1	0	1	0	0		0	0	0	0		0	1	0	

Table D.21: Support on Mathematics Resources

Survey 2 Question 13(a) and Survey 3 Question 22(a)
Would you recommend the mathematics lessons on Blackboard to others? (Yes/No). Please give reasons for your choice of answer:

04/05 Total *N* = 40 Term 2 *N* = 5, Term 3 *N* = 17
05/06 Total *N* = 42 Term 2 *N* = 30, Term 3 *N* = 27

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	Yes	-	-	1	5	4	5		2	0	0	0	0		0	0	7	0		0	6	0	
	No	-	-	0	0	0	1		2	0	0	0	0		0	0	1	0		0	1	0	
Summer	Yes	2	1	4	5	5	1		4	3	1	0	2		0	1	3	0		0	6	0	
	No	0	2	1	1	0	0		0	1	0	0	0		0	0	0	0		0	1	0	
Response Rates: 04/05 13% Term 2, 43% Term 3; 05/06 71% Term 2, 64% Term 3																							
Spring (Yes)	Good information	-	-	1	0	0	0		1	0	0	0	0		0	0	3	0		0	2	0	
	Revision purposes	-	-	0	1	1	1		1	0	0	0	0		0	0	0	0		0	0	0	
	Simpler to understand	-	-	0	0	0	0		0	0	0	0	0		0	0	1	0		0	0	0	
	Extra resource	-	-	0	0	0	1		0	0	0	0	0		0	0	3	0		0	2	0	
	Support	-	-	0	1	0	0		1	0	0	0	0		0	0	0	0		0	1	0	
Spring (No)	Teacher is better	-	-	0	0	0	1		0	0	0	0	0		0	0	1	0		0	1	0	
Summer (Yes)	Good information	1	0	0	0	0	0		0	0	0	0	1		0	0	0	0		0	0	0	
	Revision purposes	0	0	0	0	1	0		1	0	0	0	0		0	0	1	0		0	0	0	
	Simpler to understand	0	0	1	0	0	0		1	0	0	0	0		0	0	0	0		0	1	0	
	Extra resource	0	0	1	2	0	0		0	0	0	0	1		0	0	0	0		0	1	0	
	Support	0	0	0	2	2	0		0	3	0	0	0		0	0	1	0		0	1	0	

Table D.22: Recommendation of Mathematics Resources

Survey 1 Question 6(a), Survey 2 Question 10(a) and Survey 3 Question 15(a)
Would it be / Has it been useful to have replays or reviews of previous mathematics lessons available so that the lesson could be looked at again at another time? (Yes/No/Don't Know). Please give reasons for your choice of answer:

04/05 Total *N* = 112
Term 1 *N* = 94
Total *N* = 40
Term 2 *N* = 6,
Term 3 *N* = 19
05/06 Total *N* = 125
Term 1 *N* = 117
Total *N* = 40
Term 2 *N* = 30,
Term 3 *N* = 28

Term Time	**Category**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
1	Yes	5	6	10	12	8	4		8	9	8	13	11		6	5	10	0		10	11	10	
	No	0	0	5	3	3	1		1	5	0	2	2		0	2	0	0		3	2	4	
	Don't know	0	1	0	0	0	3		1	0	2	0	3		6	0	5	0		0	3	0	
2	Yes	-	-	1	4	4	6		3	0	0	0	0		0	0	8	0		0	6	0	
	No	-	-	0	1	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Don't know		-	0	0	0	0		1	0	0	0	0		0	0	0	0		0	1	0	
3	Yes	2	2	3	4	4	1		4	4	1	0	2		0	1	3	1		0	6	0	
	No	1	1	1	1	1	0		0	0	0	0	0		0	0	0	0		0	2	0	
	Don't know	0	0	0	1	1	0		0	0	0	0	0		0	0	0	0		0	0	0	
Response Rates: 04/05 84% Term 1, 15% Term 2, 48% Term 3; 05/06 94% Term 1, 71% Term 2, 67% Term 3																							
1Y	To refresh	3	5	6	7	7	2		4	10	3	6	0		5	2	7	0		10	7	6	
	Revision	1	0	2	0	5	0		2	0	1	0	2		2	1	1	0		1	1	2	
	Support	3	0	3	2	2	1		1	2	0	4	3		0	3	1	0		0	1	2	
	To catch-up	0	0	3	0	3	0		1	0	1	0	0		1	1	0	0		2	1	1	
1N	Do Already	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	1	0	
	Apathy	0	0	0	1	0	0		0	0	0	0	0		0	0	0	0		0	1	0	
	Not needed	0	0	0	0	0	1		0	0	0	0	1		0	0	0	0		0	0	0	
	Long Day	0	0	0	0	0	0		1	0	0	0	1		0	0	0	0		0	0	0	
1 DK	Never tried	0	0	0	0	0	0		0	0	0	0	0		1	0	1	0		0	0	0	
	Depends	0	0	0	0	0	2		0	0	1	0	0		0	0	2	0		0	1	0	
2Y	To refresh	-	-	0	0	1	4		1	0	0	0	0		0	0	6	0		0	2	0	
	Revision	-	-	0	1	1	0		1	0	0	0	0		0	0	1	0		0	0	0	
	Support	-	-	0	0	0	0		1	0	0	0	0		0	0	0	0		0	3	0	
	To catch-up	-	-	0	0	1	0		0	0	0	0	0		0	0	1	0		0	0	0	
3Y	To refresh	1	0	1	0	1	0		0	1	1	0	0		0	0	3	1		0	3	0	
	Revision	0	0	0	1	1	0		1	0	0	0	0		0	0	0	0		0	1	0	
	Support	0	0	0	0	1	0		0	1	0	0	0		0	0	0	0		0	0	0	
	To catch-up	0	0	0	0	1	0		0	0	0	0	0		0	0	0	0		0	0	0	

Table D.23: Usefulness of Availability of Mathematics Resources

Survey 3 Question 31 *Have you had any extra mathematics support over the year? (Yes/No). If you answered YES, please describe what support you have had.*																							
04/05 Total *N* = 112 Term 3 *N* = 32 05/06 Total *N* = 125 Term 3 *N* = 64																							
Term Time	**Category**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Summer	Yes	0	2	0	0	1	0		0	1	0	1	2		1	1	0	2		0	1	0	
	No	2	2	0	9	5	6		4	3	5	9	11		9	6	9	1		0	3	0	
Response Rates: 04/05 29% Term 3; 05/06 51% Term 3																							
Summer (Yes)	Catch-up, Retake	0	0	0	0	0	1		0	0	1	0	0		0	0	1	2		0	1	0	
	Home tutor, Work support	0	0	0	0	1	0		0	0	0	0	1		1	0	0	0		0	0	0	
	Parent	0	0	0	0	0	0		0	1	1	0	0		0	0	0	0		0	0	0	
	Text books	0	0	0	0	0	0		1	1	0	0	1		0	0	0	0		0	0	0	
	Teacher, tutor, lecturer	0	2	0	0	0	0		1	1	0	1	2		0	0	1	0		0	0	0	
	Other Students	0	1	0	0	0	0		1	0	0	1	2		0	0	0	0		0	0	0	

Table D.24: Other Mathematics Support

Survey 2 Question 15(a) *Was it easy to get the support you needed in mathematics? (Yes/No/Not applicable). Please give reasons for your choice of answer:*																							
04/05 Total *N* = 112 Term 2 *N* = 35 05/06 Total *N* = 125 Term 2 *N* = 56																							
Term Time	**Category**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	Yes	-	-	5	5	6	1		5	3	5	6	9		2	0	3	0		0	3	0	
	No	-	-	1	0	0	0		0	0	0	0	4		0	0	1	0		0	1	0	
	N/A	-	-	6	1	2	1		0	0	1	6	3		6	0	2	0		0	3	0	
Response Rates: 04/05 33% Term 2; 05/06 47% Term 2																							
Spring (Yes)	Students	-	-	1	1	0	0		0	0	1	0	0		0	0	0	0		0	0	0	
	Teacher Tutor Lecturer	-	-	2	4	3	0		1	3	4	2	3		1	0	2	0		0	0	0	
	Ask	-	-	0	0	2	0		0	0	0	0	0		0	0	0	0		0	3	0	
Spring (No)	Day release	-	-	1	0	0	0		0	0	0	0	2		0	0	0	0		0	0	0	
Spring (DK)	Not needed	-	-	1	0	1	0		0	0	1	0	1		3	0	2	0		0	0	0	

Table D.25: Accessibility of Other Mathematics Support

Survey 1 Question 1, Survey 2 Question 1 and Survey 3 Question 1
How would you rate your ability in mathematics (now)?

04/05 Total *N* = 112
Total *N* = 107
Total *N* = 112
05/06 Total *N* = 125
Total *N* = 118
Total *N* = 125

Term Time	**Category**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Autumn	Extremely Good	0	0	2	0	1	1		0	0	0	1	1		0	0	1	0		0	0	0	
	Very Good	0	0	0	2	3	1		1	2	0	0	2		4	1	2	0		2	2	4	
	Good	2	0	8	7	7	3		7	10	5	9	7		3	4	8	0		7	6	7	
	Average	2	4	1	6	0	2		1	0	4	0	6		3	2	3	0		0	5	0	
	Poor	1	2	4	0	0	1		1	1	1	6	0		2	0	1	0		4	2	3	
	Very Poor	0	1	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Extremely Poor	0	0	0	0	0	0		0	1	0	0	0		0	0	0	0		0	1	0	
Spring	Extremely Good	-	-	0	1	1	2		0	0	0	0	2		1	0	1	0		0	0	0	
	Very Good	-	-	1	0	3	1		5	2	1	0	1		2	0	2	0		0	5	0	
	Good	-	-	9	6	9	3		3	2	3	11	8		3	0	5	0		0	7	0	
	Average	-	-	4	4	0	2		1	0	2	0	5		2	0	4	0		0	2	0	
	Poor	-	-	1	0	0	0		0	0	0	1	0		0	0	1	0		0	0	0	
	Very Poor	-	-	0	0	0	0		0	0	0	0	0		0	0	1	0		0	0	0	
	Extremely Poor	-	-	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Summer	Extremely Good	0	1	1	1	1	1		1	0	0	0	1		1	0	1	1		0	1	0	
	Very Good	1	0	1	2	3	1		4	4	2	1	4		3	1	1	0		0	1	0	
	Good	4	3	4	7	9	5		5	3	2	11	8		6	6	5	3		0	6	0	
	Average	0	3	1	5	0	0		0	1	1	0	2		0	0	4	0		0	2	0	
	Poor	0	0	0	0	0	0		0	0	1	1	0		0	1	1	0		0	1	0	
	Very Poor	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	1	0	
	Extremely Poor	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	

Response Rates: 04/05 85% Term 1, 41% Term 2, 52% Term 3; 05/06 80% Term 1, 73% Term 2, 91% Term 3

Table D.26: Students Personal Mathematical Ability Rating

Survey 1 Question 2, Survey 2 Question 2 and Survey 3 Question 2 How would you compare your mathematics ability to others in your group (now)?																							
04/05 Total *N* = 112 **Total *N* = 107** **Total *N* = 112** **05/06 Total *N* = 125** **Total *N* = 118** **Total *N* = 125**		Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term Time	**Category**																						
Autumn	Very Much Better	0	0	1	0	0	0		0	0	0	0	2		0	0	0	0		0	0	1	
	Much Better	0	0	1	1	0	2		1	0	0	1	1		2	0	2	0		0	1	0	
	Better	0	1	5	3	8	1		2	8	2	6	1		1	5	2	0		5	3	12	
	Same	2	2	5	9	1	4		6	0	5	1	11		6	2	8	0		2	11	0	
	Worse	2	4	2	2	2	1		1	5	3	8	1		3	0	3	0		6	0	1	
	Much Worse	0	0	1	0	1	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Very Much Worse	0	0	0	0	0	0		0	1	0	0	0		0	0	0	0		0	1	0	
Spring	Very Much Better	-	-	0	1	0	2		0	0	0	0	2		0	0	1	0		0	0	0	
	Much Better	-	-	1	0	1	0		0	0	1	0	0		2	0	0	0		0	2	0	
	Better	-	-	4	1	5	1		4	1	0	6	1		1	0	5	0		0	2	0	
	Same	-	-	5	9	5	5		5	3	6	3	13		5	0	3	0		0	10	0	
	Worse	-	-	4	0	2	0		0	0	0	2	1		0	0	5	0		0	0	0	
	Much Worse	-	-	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Very Much Worse	-	-	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Summer	Very Much Better	0	1	1	0	0	1		0	1	0	0	1		0	0	2	2		0	0	0	
	Much Better	0	0	0	2	1	0		0	1	0	0	0		2	0	0	0		0	1	0	
	Better	1	0	3	1	8	1		5	4	2	10	5		1	6	2	0		0	0	0	
	Same	4	5	1	11	3	5		5	1	3	0	9		7	0	5	1		0	9	0	
	Worse	0	1	2	1	1	0		0	1	1	3	0		0	2	3	1		0	2	0	
	Much Worse	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Very Much Worse	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Response Rates: 04/05 85% Term 1, 41% Term 2, 47% Term 3; 05/06 81% Term 1, 73% Term 2, 79% Term 3																							

Table D.27: Students Group Mathematical Ability Rating

Survey 1 Question 3, Survey 2 Question 3 and Survey 3 Question 3 How would you compare your mathematics ability to people of your age in general (now)?																							
04/05 Total *N* = 112 **Total *N* = 107** **Total *N* = 112** **05/06 Total *N* = 125** **Total *N* = 118** **Total *N* = 125**		Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunication (FT)		Fabricators (PT)	
Term Time	**Category**																						
Autumn	Very Much Better	0	0	0	0	0	0		0	0	0	0	1		0	0	2	0		0	1	1	
	Much Better	0	0	3	2	0	0		3	1	0	1	1		1	0	0	0		2	0	1	
	Better	2	0	9	8	9	2		3	10	1	8	9		6	3	4	0		6	5	9	
	Same	2	4	2	5	0	6		4	0	8	2	5		4	2	7	0		0	9	0	
	Worse	1	3	1	0	2	0		0	2	1	5	0		1	2	2	0		4	0	3	
	Much Worse	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		1	0	0	
	Very Much Worse	0	0	0	0	0	0		0	1	0	0	0		0	0	0	0		0	1	0	
Spring	Very Much Better	-	-	1	1	0	2		0	0	0	0	1		0	0	1	0		0	0	0	
	Much Better	-	-	1	2	0	0		2	0	0	1	4		3	0	1	0		0	1	0	
	Better	-	-	9	7	3	2		6	4	0	9	8		2	0	3	0		0	7	0	
	Same	-	-	3	1	9	4		1	0	6	0	3		3	0	6	0		0	6	0	
	Worse	-	-	1	0	1	0		0	0	0	2	0		0	0	2	0		0	0	0	
	Much Worse	-	-	0	0	0	0		0	0	0	0	0		0	0	1	0		0	0	0	
	Very Much Worse	-	-	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Summer	Very Much Better	0	1	0	1	0	1		0	0	0	0	0		0	0	2	0		0	1	0	
	Much Better	0	0	0	3	3	0		3	2	0	1	6		2	1	0	1		0	0	0	
	Better	2	3	6	7	9	1		6	5	2	1	7		5	5	4	2		0	2	0	
	Same	3	3	1	4	1	5		1	1	3	1	2		3	0	2	1		0	8	0	
	Worse	0	0	0	0	0	0		0	0	1	0	0		0	0	3	0		0	1	0	
	Much Worse	0	0	0	0	0	0		0	0	0	1	0		0	0	1	0		0	0	0	
	Very Much Worse	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Response Rates: 04/05 85% Term 1, 41% Term 2, 42% Term 3; 05/06 87% Term 1, 73% Term 2, 75% Term 3																							

Table D.28: Students Age Mathematical Ability Rating

Survey 1 Question 13, Survey 2 Question 4 and Survey 3 Question 4 *How do you feel about mathematics?*																						
04/05 Total *N* = 112 **Term 1 *N* = 94, 93, 98** **05/06 Total *N* = 125** **Term 1 *N* = 107, 108, 106**			Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term Time	**Categories & Ratings**																							
Autumn	I intensely dislike mathematics	1	0	0	0	0	0	0		1	1	2	0	2		0	0	1	0		0	0	3	
		2	0	0	0	2	1	0		2	2	0	4	3		4	1	0	0		4	4	1	
		3	2	2	5	5	3	1		5	3	3	7	5		2	2	6	0		3	5	6	
		4	0	1	2	7	4	6		1	0	3	0	4		2	1	3	0		0	3	0	
		5	2	2	4	1	0	1		1	5	1	4	0		2	3	2	0		6	2	3	
		6	1	2	4	0	3	0		0	2	1	0	0		1	0	1	0		0	1	1	
	I intensely like mathematics	7	0	0	0	0	0	0		0	1	0	1	0		1	0	2	0		0	1	0	
	Mathematics is unimportant	1	1	0	2	0	3	0		0	2	2	2	0		0	3	0	0		8	0	5	
		2	3	3	5	3	1	2		3	9	2	5	5		2	1	3	0		1	4	6	
		3	1	1	5	7	3	4		4	3	3	5	7		6	3	4	0		4	7	2	
		4	0	2	1	3	0	1		3	0	2	0	3		1	0	3	0		0	4	0	
		5	0	1	1	2	0	1		0	0	1	4	1		2	0	3	0		0	0	1	
		6	0	0	1	0	0	0		0	0	0	1	0		0	0	2	0		0	1	0	
	Mathematics is essential	7	0	0	0	0	0	0		0	0	0	1	0		1	0	0	0		0	0	0	
	Support in mathematics is unnecessary	1	4	3	3	2	1	1		2	6	1	4	3		0	1	3	0		4	3	4	
		2	1	0	2	4	4	1		2	7	2	9	4		3	2	4	0		3	5	4	
		3	0	0	6	7	3	2		4	1	2	2	4		1	1	2	0		1	5	1	
		4	0	2	1	2	0	1		1	0	2	0	5		5	0	3	0		0	1	0	
		5	0	0	1	0	1	2		1	0	1	1	0		3	1	2	0		3	2	5	
		6	0	0	2	0	1	1		0	0	0	0	0		0	1	1	0		2	0	0	
	Support in mathematics is essential	7	0	0	0	0	1	0		0	0	2	0	0		0	1	0	0		0	0	3	
Response Rates: 04/05 84%, 83%, 88% Term 1; 05/06 86%, 86%, 85% Term 1																								

Table D.29: Student Feelings about Mathematics (Autumn)

Survey 1 Question 13, Survey 2 Question 4 and Survey 3 Question 4 *How do you feel about mathematics?*																								
04/05 Total *N* = 107 **Term 2 *N* = 44, 44, 44** **05/06 Total *N* = 118** **Term 2 *N* = 75, 83, 86** **04/05 Total *N* = 112** **Term 3 *N* = 58, 58, 58** **05/06 Total *N* = 125** **Term 3 *N* = 98, 94, 90**			Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term Time	**Categories & Ratings**																							
Spring	I intensely dislike mathematics	1	-	-	1	0	0	1		0	0	0	1	2		2	0	1	0		0	2	0	
		2	-	-	1	1	6	0		2	2	1	2	4		1	0	0	0		0	2	0	
		3	-	-	3	4	5	2		6	2	3	8	6		3	0	2	0		0	7	0	
		4	-	-	1	4	0	5		1	0	2	0	4		2	0	8	0		0	3	0	
		5	-	-	6	2	2	0		0	0	0	1	0		0	0	1	0		0	0	0	
		6	-	-	3	0	0	0		0	0	0	0	0		0	0	1	0		0	0	0	
	I intensely like mathematics	7	-	-	0	0	0	0		0	0	0	0	0		0	0	1	0		0	0	0	
	Mathematics is unimportant	1	-	-	2	1	5	3		2	1	1	4	6		3	0	5	0		0	3	0	
		2	-	-	4	3	4	3		5	3	2	2	4		1	0	4	0		0	7	0	
		3	-	-	2	5	4	1		1	0	3	4	6		4	0	3	0		0	2	0	
		4	-	-	1	2	0	1		1	0	0	0	0		0	0	1	0		0	2	0	
		5	-	-	5	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
		6	-	-	1	0	0	0		0	0	0	1	0		0	0	1	0		0	0	0	
	Mathematics is essential	7	-	-	0	0	0	0		0	0	0	1	0		0	0	0	0		0	0	0	
	Support in mathematics is unnecessary	1	-	-	1	1	3	1		0	1	0	4	2		0	0	2	0		0	3	0	
		2	-	-	4	4	3	0		3	3	1	6	4		2	0	6	0		0	4	0	
		3	-	-	1	4	4	1		3	0	2	1	4		2	0	3	0		0	3	0	
		4	-	-	1	2	3	4		3	0	3	0	4		2	0	3	0		0	2	0	
		5	-	-	3	0	0	0		0	0	0	1	0		1	0	0	0		0	1	0	
	Support in mathematics is essential	6	-	-	2	0	0	1		0	0	0	0	1		1	0	0	0		0	1	0	
		7	-	-	3	0	0	1		0	0	0	0	1		0	0	0	0		0	0	0	
Summer	I intensely dislike mathematics	1	1	0	0	0	0	1		0	0	0	0	2		1	0	1	1		0	5	0	
		2	0	0	1	1	5	0		4	2	1	3	5		2	3	0	2		0	0	0	
		3	3	3	1	4	6	3		3	3	3	9	6		3	3	4	1		0	3	0	
		4	0	3	1	7	0	3		3	0	1	0	2		4	0	3	0		0	4	0	
		5	1	1	3	2	1	0		0	3	1	1	0		0	2	2	0		0	0	0	
		6	0	0	0	1	1	0		0	0	0	0	0		0	0	0	0		0	0	0	
	I intensely like mathematics	7	0	0	1	0	0	0		0	0	0	0	0		0	0	2	0		0	0	0	
	Mathematics is unimportant	1	2	2	1	2	4	1		2	3	1	2	6		3	3	3	3		0	1	0	
		2	2	1	2	4	4	3		7	4	2	6	6		1	4	2	1		0	5	0	
		3	1	4	1	5	4	3		1	0	2	5	3		5	1	5	0		0	2	0	
		4	0	0	1	3	0	0		0	0	1	0	0		1	0	0	0		0	3	0	
		5	0	0	2	1	1	0		0	1	0	0	0		0	0	1	0		0	0	0	
		6	0	0	0	0	0	0		0	0	0	0	0		0	0	1	0		0	0	0	
	Mathematics is essential	7	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	1	0	
	Support in mathematics is unnecessary	1	3	1	0	2	1	1		0	2	2	1	4		1	1	3	2		0	3	0	
		2	1	1	2	7	5	2		4	5	1	8	4		2	2	4	0		0	5	0	
		3	1	5	1	4	4	2		4	1	1	1	5		2	2	2	0		0	2	0	
		4	0	0	1	2	0	0		2	0	2	0	1		4	0	3	0		0	2	0	
		5	0	0	2	0	3	1		0	0	0	2	0		1	2	0	0		0	0	0	
	Support in mathematics is essential	6	0	0	0	0	0	1		0	0	0	1	0		0	1	0	1		0	0	0	
		7	0	0	1	0	0	0		0	0	0	0	1		0	0	0	1		0	0	0	
Response Rates: 04/05 44%, 44%, 44% Term 2, 52%, 52%, 52% Term 3; 05/06 75%, 83%, 86% Term 2, 78%, 75%, 72% Term 3																								

Table D.30: Student Feelings about Mathematics (Spring and Summer)

Survey 1 Question 4 *Do you find it easy to catch up mathematics work if you have been absent from class?*																							
04/05 Total *N* = 112 **Term 1 *N* = 97** **05/06 Total *N* = 125** **Term 1 *N* = 109**		Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term Time	**Category**																						
Autumn	Always	0	1	3	5	0	2		0	1	0	0	2		3	1	3	0		0	4	1	
	Usually	1	3	7	7	10	3		9	11	6	6	7		6	3	9	0		8	8	7	
	Occasionally	4	3	4	2	1	3		1	1	4	5	5		2	3	2	0		4	2	4	
	Never	0	0	1	1	0	0		0	1	0	5	2		1	0	1	0		1	2	2	
Response Rates: 04/05 87% Term 1; 05/06 87% Term 1																							

Table D.31: Student Catch-Up Aptitude

Survey 1 Question 7, Survey 2 Question 5 and Survey 3 Question 29 Do you find mathematics easy to remember?																							
04/05 Total *N* = 112 **Total *N* = 107** **Total *N* = 112** **05/06 Total *N* = 125** **Total *N* = 118** **Total *N* = 125**		Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term Time	**Category**																						
Autumn	Always	0	1	2	1	1	1		0	1	1	0	2		1	1	0	0		1	1	1	
	Usually	2	1	7	10	6	6		7	7	5	4	12		8	5	10	0		5	8	6	
	Occasionally	3	4	6	3	4	1		3	4	3	12	2		3	1	4	0		7	7	7	
	Never	0	1	0	1	0	0		0	2	1	0	0		0	0	1	0		0	0	0	
Spring	Always	-	-	2	1	0	1		1	1	1	0	1		0	0	1	0		0	0	0	
	Usually	-	-	6	3	9	5		7	0	4	5	12		8	0	7	0		0	8	0	
	Occasionally	-	-	6	7	4	2		1	3	1	6	3		0	0	4	0		0	6	0	
	Never	-	-	1	0	0	0		0	0	0	1	0		0	0	2	0		0	0	0	
Summer	Always	0	0	0	1	0	0		4	1	0	0	1		1	0	0	0		0	0	0	
	Usually	2	0	0	2	7	4		1	2	2	7	8		7	4	7	2		0	2	0	
	Occasionally	0	3	1	4	1	2		1	1	3	5	3		2	2	1	1		0	2	0	
	Never	0	1	0	2	0	0		0	0	0	1	1		0	1	1	0		0	0	0	
Response Rates: 04/05 84% Term 1, 41% Term 2, 34% Term 3; 05/06 87% Term 1, 73% Term 2, 53% Term 3																							

Table D.32: Ease of Remembering Mathematics

Survey 1 Question 14, Survey 2 Question 17 and Survey 3 Question 8 *How do you feel about using computers?*																						
04/05 Total *N* = 112 **Term 1 *N* = 95, 86, 95** **05/06 Total *N* = 125** **Term 1 *N* = 107, 109, 101**			Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term Time	**Categories & Ratings**																							
Autumn	I intensely dislike using computers	1	2	0	1	1	3	1		1	4	3	2	3		0	1	4	0		4	10	2	
		2	2	3	8	7	4	2		3	6	0	4	3		6	5	4	0		4	3	3	
		3	0	0	4	4	2	1		3	3	3	7	4		4	1	3	0		2	2	7	
		4	0	2	1	2	0	3		3	0	3	0	4		2	0	3	0		0	1	0	
		5	1	1	0	1	1	1		0	1	1	2	0		0	0	0	0		2	0	1	
	I intensely like using computers	6	0	0	1	0	1	0		0	0	0	1	1		0	0	1	0		1	0	0	
		7	0	1	0	0	0	0		0	0	0	0	1		0	0	0	0		0	0	1	
	Using computers is unimportant	1	3	1	5	2	4	1		1	9	3	3	3		0	1	3	0		7	8	4	
		2	1	1	6	6	3	1		3	3	0	1	3		2	4	6	0		4	2	3	
		3	1	2	1	3	3	4		4	1	4	0	6		4	2	3	0		1	2	4	
		4	0	2	1	4	0	2		1	0	3	2	4		5	0	3	0		0	4	0	
		5	0	0	2	0	1	0		1	0	0	0	0		1	0	0	0		1	0	2	
	Using computers is essential	6	0	1	0	0	0	0		0	1	0	1	0		0	0	0	0		0	0	0	
		7	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	1	
	Support in using computers is unnecessary	1	4	3	1	1	1	0		1	4	1	4	4		0	0	3	0		4	4	2	
		2	1	1	2	1	4	1		3	0	0	3	1		2	3	1	0		2	3	3	
		3	0	0	3	8	2	0		3	6	2	5	4		1	0	4	0		2	3	5	
		4	0	2	2	5	0	5		2	0	5	0	4		4	0	4	0		0	5	0	
	Support in using computers is essential	5	0	0	4	0	2	0		1	2	0	1	2		3	1	2	0		1	0	2	
		6	0	0	2	0	1	2		0	1	0	2	1		2	1	1	0		2	0	0	
		7	0	1	1	0	1	0		0	1	2	1	0		0	2	0	0		2	1	2	
		7	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Response Rates: 04/05 85%, 77%, 85% Term 1; 05/06 86%, 87%, 81% Term 1																						

Table D.33: Student Feelings about Computers (Autumn)

Survey 1 Question 14, Survey 2 Question 17 and Survey 3 Question 8
How do you feel about using computers?

04/05 Total *N* = 107
Term 2 *N* = 39, 43, 39
Total *N* = 112
Term 3 *N* = 51, 58, 58
05/06 Total *N* = 118
Term 2 *N* = 71, 88, 87
Total *N* = 125
Term 3 *N* = 94, 94, 94

Term Time	**Categories & Ratings**		Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	I intensely dislike using computers	1	-	-	0	1	2	1		1	1	0	0	3		1	0	3	0		0	5	0	
		2	-	-	7	6	3	1		2	1	2	6	0		3	0	1	0		0	5	0	
		3	-	-	5	2	4	1		6	1	3	4	6		4	0	7	0		0	2	0	
		4	-	-	1	2	0	3		0	0	1	0	5		0	0	2	0		0	2	0	
	I intensely like using computers	5	-	-	1	0	0	2		0	0	0	2	0		0	0	0	0		0	0	0	
		6	-	-	0	0	2	0		0	0	0	0	0		0	0	1	0		0	0	0	
		7	-	-	0	0	0	0		0	0	0	0	2		0	0	0	0		0	0	0	
	Using computers is unimportant	1	-	-	1	2	1	1		2	1	0	0	4		1	0	2	0		0	6	0	
		2	-	-	4	3	3	4		3	2	2	3	2		3	0	0	0		0	4	0	
		3	-	-	6	3	3	2		4	1	2	8	5		2	0	9	0		0	3	0	
		4	-	-	4	3	5	0		0	0	2	1	3		2	0	1	0		0	1	0	
	Using computers is essential	5	-	-	0	0	0	1		0	0	0	0	0		0	0	1	0		0	0	0	
		6	-	-	0	0	0	0		0	0	0	0	1		0	0	1	0		0	0	0	
		7	-	-	0	0	0	0		0	0	0	0	1		0	0	0	0		0	0	0	
	Support in using computers is unnecessary	1	-	-	0	2	3	0		0	0	0	1	3		0	0	1	0		0	3	0	
		2	-	-	2	2	2	0		2	3	1	8	2		1	0	2	0		0	3	0	
		3	-	-	7	1	3	2		2	0	3	1	4		3	0	3	0		0	4	0	
		4	-	-	2	4	1	4		2	0	1	0	4		3	0	5	0		0	1	0	
	Support in using computers is essential	5	-	-	0	2	1	0		1	0	1	1	1		0	0	1	0		0	1	0	
		6	-	-	3	0	0	0		2	0	0	1	0		0	0	1	0		0	0	0	
		7	-	-	0	0	0	2		0	0	0	0	2		1	0	2	0		0	2	0	
Summer	I intensely dislike using computers	1	3	0	2	3	5	2		1	5	1	7	1		0	4	3	2		0	3	0	
		2	1	3	2	5	4	0		3	1	0	4	4		3	3	1	0		0	5	0	
		3	0	2	1	2	0	4		3	0	5	0	5		6	0	7	0		0	3	0	
		4	1	1	1	5	0	1		3	0	0	1	3		1	0	1	0		0	1	0	
	I intensely like using computers	5	0	0	1	0	1	0		0	1	0	0	1		0	0	0	0		0	0	0	
		6	0	1	0	0	1	0		0	0	0	0	1		0	0	0	0		0	0	0	
		7	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Using computers is unimportant	1	2	1	2	2	2	2		1	6	2	1	3		1	1	4	3		0	4	0	
		2	2	3	3	7	6	0		4	1	1	9	6		4	4	2	0		0	5	0	
		3	1	1	0	2	5	5		3	0	1	3	4		4	2	5	1		0	1	0	
		4	0	1	1	4	0	0		2	0	2	0	2		1	0	1	0		0	1	0	
	Using computers is essential	5	0	0	1	0	0	0		0	1	0	0	0		0	1	0	0		0	1	0	
		6	0	1	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
		7	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Support in using computers is unnecessary	1	2	2	0	2	1	2		1	1	0	0	2		1	0	2	0		0	1	0	
		2	2	2	0	4	6	0		4	3	0	5	4		2	2	3	1		0	6	0	
		3	1	2	1	2	2	3		2	2	1	7	7		4	1	2	3		0	2	0	
		4	0	0	1	6	0	0		3	0	3	0	1		3	0	3	0		0	2	0	
	Support in using computers is essential	5	0	0	4	1	3	2		0	1	0	0	1		0	2	2	0		0	0	0	
		6	0	1	1	0	0	0		0	1	0	1	0		0	2	0	0		0	0	0	
		7	0	0	0	0	1	0		0	0	2	0	0		0	1	0	0		0	1	0	

Response Rates: 04/05 36%, 40%, 36% Term 2, 46%, 52%, 52% Term 3; 05/06 60%, 75%, 74% Term 2, 75%, 75%, 75% Term 3

Table D.34: Student Feelings about Computers (Spring & Summer)

Survey 1 Question 15, Survey 2 Question 18 and Survey 3 Question 9
How do you rate your ability in using computers for general tasks (now)?

04/05 Total *N* = 112 **Total *N* = 107** **Total *N* = 112** **05/06 Total *N* = 125** **Total *N* = 118** **Total *N* = 125**		Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term Time	**Category**																						
Autumn	Extremely Good	0	0	3	2	1	1		0	5	2	1	3		0	1	1	0		1	3	3	
	Very Good	1	0	4	7	6	2		4	5	2	4	3		8	2	5	0		4	8	0	
	Good	2	2	5	3	2	4		5	3	5	8	7		4	4	7	0		6	2	9	
	Average	0	4	1	3	0	1		1	0	0	0	2		0	0	2	0		0	3	0	
	Poor	2	0	1	0	2	0		0	1	1	1	0		0	0	0	0		1	0	2	
	Very Poor	0	0	0	0	0	0		0	0	0	1	1		0	0	0	0		1	0	0	
	Extremely Poor	0	1	1	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Spring	Extremely Good	-	-	3	3	0	1		2	0	0	0	3		1	0	1	0		0	4	0	
	Very Good	-	-	2	4	6	2		3	1	2	2	4		4	0	6	0		0	5	0	
	Good	-	-	6	3	3	5		3	2	2	4	5		3	0	4	0		0	3	0	
	Average	-	-	2	1	0	1		1	0	2	2	4		0	0	3	0		0	2	0	
	Poor	-	-	0	0	0	0		0	0	0	1	0		0	0	0	0		0	0	0	
	Very Poor	-	-	0	0	2	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Extremely Poor	-	-	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Summer	Extremely Good	0	0	0	1	1	2		0	1	0	1	2		0	1	1	1		0	2	0	
	Very Good	2	0	3	9	6	1		3	4	2	3	5		5	2	5	1		0	4	0	
	Good	2	3	1	3	4	4		6	3	3	6	4		3	5	5	2		0	3	0	
	Average	0	3	1	2	0	0		1	0	1	0	4		2	0	1	0		0	3	0	
	Poor	0	0	1	0	1	0		0	0	0	3	0		0	0	0	0		0	0	0	
	Very Poor	0	1	1	0	1	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Extremely Poor	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	

Response Rates: 04/05 83% Term 1, 37% Term 2, 51% Term 3; 05/06 98% Term 1, 70% Term 2, 79% Term 3

Table D.35: Students Personal ICT Ability Rating

Survey 1 Question 16, Survey 2 Question 19 and Survey 3 Question 10
How would you compare your ability in using computers for general tasks to others in your group (now)?

04/05 Total *N* = 112
Total *N* = 107
Total *N* = 112
05/06 Total *N* = 125
Total *N* = 118
Total *N* = 125

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Autumn	Very Much Better	0	1	2	0	0	1		0	2	3	0	1		0	1	0	0		0	1	1	
	Much Better	0	0	1	2	2	0		0	1	1	4	2		1	2	3	0		1	2	3	
	Better	1	1	6	7	6	2		4	10	1	7	5		4	2	3	0		8	2	6	
	Same	1	4	3	5	0	5		5	0	5	1	6		7	2	8	0		0	9	0	
	Worse	2	0	2	1	2	0		1	0	0	4	1		0	0	1	0		2	2	3	
	Much Worse	0	1	0	0	1	0		0	1	0	0	1		0	0	0	0		2	0	1	
	Very Much Worse	0	0	1	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Spring	Very Much Better	-	-	2	1	0	2		1	0	0	0	1		1	0	2	0		0	1	0	
	Much Better	-	-	3	0	0	1		0	1	1	2	0		2	0	1	0		0	2	0	
	Better	-	-	3	5	8	0		2	1	1	2	3		2	0	2	0		0	2	0	
	Same	-	-	2	5	0	5		5	1	4	1	4		9	0	9	0		0	9	0	
	Worse	-	-	3	0	1	0		1	0	0	0	0		0	0	0	0		0	0	0	
	Much Worse	-	-	0	0	0	0		0	0	0	3	0		0	0	0	0		0	0	0	
	Very Much Worse	-	-	0	0	2	0		0	0	0	0	0		0	0	0	0		0	0	0	
Summer	Very Much Better	0	0	0	0	0	2		0	1	0	1	1		0	1	0	0		0	1	0	
	Much Better	0	0	3	3	1	0		1	2	1	2	1		1	2	3	1		0	2	0	
	Better	3	1	0	6	9	3		2	4	2	6	4		5	5	2	3		0	1	0	
	Same	1	6	1	4	1	2		6	1	3	0	8		4	0	6	0		0	8	0	
	Worse	1	0	3	2	1	0		1	0	0	4	1		0	0	1	0		0	0	0	
	Much Worse	0	0	0	0	1	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Very Much Worse	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	

Response Rates: 04/05 86% Term 1, 33% Term 2, 52% Term 3; 05/06 95% Term 1, 71% Term 2, 75% Term 3

Table D.36: Students Group ICT Ability Rating

Survey 1 Question 17, Survey 2 Question 20 and Survey 3 Question 11 *How would you compare your ability in using computers for general tasks to people of your age in general (now)?*																							
04/05 Total *N* = 112 **Total *N* = 107** **Total *N* = 112** **05/06 Total *N* = 125** **Total *N* = 118** **Total *N* = 125**		Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term	**Category**																						
Autumn	Very Much Better	0	1	2	1	0	1		0	2	2	0	1		0	0	0	0		0	2	1	
	Much Better	0	0	2	1	1	1		0	3	2	2	2		2	2	4	0		2	4	2	
	Better	1	2	5	9	7	2		4	7	0	10	6		2	1	2	0		6	2	5	
	Same	1	2	3	3	1	4		5	0	5	1	6		8	2	6	0		0	8	0	
	Worse	2	2	2	1	1	0		1	2	1	3	1		0	2	3	0		5	0	4	
	Much Worse	0	0	0	0	1	0		0	0	0	0	0		0	0	0	0		0	0	2	
	Very Much Worse	0	0	1	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Spring	Very Much Better	-	-	1	1	0	1		1	0	0	0	3		1	0	2	0		0	2	0	
	Much Better	-	-	4	4	2	2		2	2	1	1	1		0	0	0	0		0	2	0	
	Better	-	-	3	3	6	0		2	1	2	4	9		2	0	4	0		0	5	0	
	Same	-	-	2	3	0	5		3	0	3	2	3		5	0	7	0		0	3	0	
	Worse	-	-	5	0	1	0		1	0	0	2	0		0	0	1	0		0	2	0	
	Much Worse	-	-	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
	Very Much Worse	-	-	0	0	2	0		0	0	0	0	0		0	0	0	0		0	0	0	
Summer	Very Much Better	0	0	0	1	0	2		0	1	0	1	0		0	1	1	0		0	2	0	
	Much Better	0	0	3	6	4	0		1	2	3	3	4		1	2	1	1		0	1	0	
	Better	3	2	1	4	5	2		6	5	3	8	5		6	4	5	3		0	2	0	
	Same	1	4	1	4	1	3		2	0	0	0	6		3	0	4	0		0	6	0	
	Worse	1	1	2	0	2	0		1	0	0	0	0		0	1	0	0		0	1	0	
	Much Worse	0	0	0	0	1	0		0	0	0	0	0		0	0	1	0		0	0	0	
	Very Much Worse	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Response Rates: 04/05 86% Term 1, 36% Term 2, 51% Term 3; 05/06 87% Term 1, 71% Term 2, 75% Term 3																							

Table D.37: Students Age ICT Ability Rating

Survey 3 Question 16 *Have the mathematics lessons available on Blackboard provided you with adequate support?*																							
04/05 Total *N* = 40 **Term 3 *N* = 19** **05/06 Total *N* = 42** **Term 3 *N* = 28**		Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Term Time	**Category**																						
Summer	Always	0	0	0	0	1	1		0	1	0	0	0		0	0	0	0		0	1	0	
	Usually	1	0	4	6	2	0		4	2	1	0	1		0	1	1	1		0	5	0	
	Occasionally	1	3	1	0	2	0		0	1	0	0	1		0	0	2	0		0	2	0	
	Never	1	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Response Rates: 04/05 48% Term 3; 05/06 67% Term 3																							

Table D.38: Mathematics Resource Impact upon Support

Survey 3 Question 19 *Do the mathematics lessons available on Blackboard help you to remember mathematics more easily?*																					
04/05 Total *N* = 40 **Term 3 *N* = 18** **05/06 Total *N* = 42** **Term 3 *N* = 38**																					
Term Time	**Category**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Summer	Always	0	1	0	0	0	1		0	0	0	0	0		0	0	0	0		0	3	0	
	Usually	0	2	3	0	3	4		1	3	3	0	1		1	1	3	0		0	3	0	
	Occasionally	2	3	2	2	2	1		0	1	0	0	0		1	0	1	0		0	1	0	
	Never	1	4	0	1	0	0		0	0	0	0	0		0	0	0	0		0	1	0	
Response Rates: 04/05 45% Term 3; 05/06 90% Term 3																					

Table D.39: Mathematics Resource Impact upon Remembering

Survey 3 Question 20 *Do the mathematics lessons available on Blackboard help you to understand mathematics more?*																					
04/05 Total *N* = 40 **Term 3 *N* = 18** **05/06 Total *N* = 42** **Term 3 *N* = 28**																					
Term Time	**Category**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Summer	Always	0	0	0	1	0	0		0	0	0	0	0		0	0	1	0		0	3	0	
	Usually	0	0	4	5	3	1		4	3	1	0	1		0	0	0	0		0	2	0	
	Occasionally	2	3	1	0	2	0		0	1	0	0	1		0	1	2	0		0	3	0	
	Never	1	0	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	
Response Rates: 04/05 45% Term 3; 05/06 67% Term 3																					

Table D.40: Mathematics Resources Impact upon Perceived Understanding

Survey 1 Question 8 and Survey 3 Question 26
Do you take time to review your mathematics class work in your own time?

04/05 Total *N* = 112
Total *N* = 72
05/06 Total *N* = 125
Total *N* = 83

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Autumn	Yes, after every lesson	1	1	1	0	0	0		0	0	3	1	0		0	0	1	0		1	2	3	
	Yes, after some lessons	3	3	5	8	4	2		1	2	0	8	7		1	1	1	0		3	7	0	
	Yes, but only for revision	1	2	9	5	6	6		6	11	5	5	7		8	5	12	0		9	5	8	
	No, never	0	0	0	2	1	1		3	1	1	2	2		3	1	2	0		0	3	3	
Summer	Yes, after every lesson	0	0	0	0	1	1		0	0	1	3	1		0	0	0	0		0	0	0	
	Yes, after some lessons	0	4	0	1	2	1		0	0	2	3	1		0	1	0	1		0	0	0	
	Yes, but only for revision	2	0	1	3	5	4		2	3	3	5	10		7	5	6	1		0	3	0	
	No, never	0	0	0	5	1	0		2	1	0	2	1		3	1	3	1		0	1	0	

Response Rates: 04/05 85% Term 1, 50% Term 3; 05/06 88% Term 1, 78% Term 3

Table D.41: Reviewing Mathematics Class Work

Survey 1 Question 9
How do you revise for mathematics tests?

04/05 Total *N* = 112
05/06 Total *N* = 125

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Autumn	Revision sheets	3	3	11	8	5	2		6	8	8	6	11		4	5	5	0		9	8	7	
	Redo class worksheets	4	4	9	12	4	3		3	6	5	6	13		2	2	1	0		3	5	5	
	Use textbooks	3	0	7	4	1	2		3	5	2	3	3		0	3	3	0		7	2	3	
	Read through class notes	4	6	14	12	9	6		8	12	9	14	16		10	5	7	0		9	12	11	
	I don't revise	0	0	0	2	0	1		0	0	0	0	1		0	0	3	0		0	2	0	
	Other	0	0	0	2	0	0		0	0	1	0	1		0	0	1	0		0	2	0	

Table D.42: Mathematics Revision Strategies

Survey 1 Question 10 and Survey 3 Question 28
When I learn a new topic in mathematics …

04/05 Total *N* = 112
05/06 Total *N* = 125

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Autumn	I usually understand it straight away	1	0	11	3	8	3		2	10	1	5	8		5	5	1	0		6	3	7	
	I understand parts of it straight away	2	3	8	10	3	3		6	5	4	4	6		4	2	9	0		4	10	5	
	I find some topics easy and some difficult	2	3	4	7	0	4		5	4	7	2	8		4	1	8	0		4	3	2	
	It takes me a long time to grasp	2	2	4	0	0	0		0	4	0	2	0		2	1	0	0		4	0	2	
	I need a lot of explanation	2	1	4	0	1	0		0	4	0	8	1		1	1	2	0		5	5	4	
	I have to work hard to understand	2	2	2	2	1	0		0	4	2	0	1		1	0	2	0		5	2	4	
	I need extra help to understand	2	1	2	0	0	0		0	2	0	0	0		0	0	1	0		2	4	0	
Summer	I usually understand it straight away	1	0	0	1	6	4		1	4	0	9	3		6	5	2	2		0	0	0	
	I understand parts of it straight away	0	1	1	5	2	1		2	0	3	1	8		2	1	3	0		0	3	0	
	I find some topics easy and some difficult	0	2	1	4	0	2		2	0	3	1	5		3	1	6	0		0	0	0	
	It takes me a long time to grasp	0	2	0	1	0	0		1	0	1	3	1		0	1	3	1		0	0	0	
	I need a lot of explanation	0	1	0	0	0	0		0	0	0	3	1		1	2	1	1		0	1	0	
	I have to work hard to understand	0	1	0	1	0	1		0	0	1	1	3		1	2	1	0		0	0	0	
	I need extra help to understand	0	0	0	0	0	0		0	0	0	0	1		0	1	2	0		0	0	0	

Table D.43: Perceived Understanding of New Topics

Survey 1 Question 11 and Survey 3 Question 25
If I miss a mathematics lesson …

04/05 Total *N* = 112
05/06 Total *N* = 125

Term Time	**Category**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Autumn	I don't miss mathematics lessons	1	3	0	11	1	2		5	1	3	2	9		3	0	6	0		1	2	3	
	I find it difficult to catch up	3	1	3	1	0	0		0	1	0	2	0		1	1	3	0		0	2	2	
	I need extra help to understand the topic	2	1	2	0	2	0		0	3	0	1	0		0	0	2	0		4	3	0	
	I use textbooks	3	0	5	1	5	2		0	6	0	6	0		0	1	2	0		5	4	7	
	I don't catch up the lesson	0	0	0	0	0	0		0	0	1	1	0		0	0	1	0		2	0	1	
	I copy the notes from a friend	0	2	11	4	5	4		5	6	3	7	7		6	4	3	0		4	9	4	
	I attempt the class worksheet	1	2	7	3	5	3		4	6	2	7	6		4	3	3	0		4	10	3	
	I ask a friend to explain it	3	1	7	4	4	1		5	6	4	6	4		2	6	5	0		7	10	4	
Summer	I don't miss mathematics lessons	0	2	0	6	1	2		3	0	3	4	4		4	0	4	0		0	0	0	
	I find it difficult to catch up	0	1	1	0	0	1		1	0	0	4	1		0	1	1	1		0	2	0	
	I need extra help to understand the topic	0	0	1	2	3	1		0	0	1	7	1		0	0	2	0		0	1	0	
	I use textbooks	2	1	0	1	5	3		1	3	1	5	0		1	2	2	0		0	0	0	
	I don't catch up the lesson	0	0	0	0	0	1		0	0	0	1	1		0	1	2	0		0	0	0	
	I copy the notes from a friend	0	1	1	2	4	2		2	1	3	7	7		7	6	6	3		0	3	0	
	I attempt the class worksheet	0	0	1	1	4	4		3	1	1	6	8		5	3	2	2		0	2	0	
	I ask a friend to explain it	0	0	1	3	3	2		1	1	2	5	6		2	4	1	3		0	1	0	

Table D.44: Actions for Catching Up Missed Lessons

Survey 1 Question 12 and Survey 3 Question 27
If I find a topic area difficult to understand …

04/05 Total *N* = 112
05/06 Total *N* = 125

Term	**Category**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Autumn	I ask for help from the lecturer during class	5	4	13	15	11	6		10	14	7	15	12		9	7	12	0		10	14	12	
	I ask for help from a friend during class	3	3	13	14	7	4		4	10	2	12	11		5	2	7	0		8	9	5	
	I ask for help from the lecturer after class	2	1	1	5	1	2		2	2	1	3	5		4	1	2	0		2	6	0	
	I ask for help from a friend after class	3	4	5	7	1	1		1	5	1	5	6		2	0	1	0		3	4	2	
	I look the topic up in a text book	4	4	3	5	3	1		3	2	1	2	5		1	2	3	0		6	5	0	
	I ask for help from a relative	0	0	5	0	3	0		0	3	1	3	3		1	0	3	0		4	3	1	
	I search the internet for information	0	0	0	1	0	0		2	0	2	0	6		0	0	2	0		1	8	0	
	I do nothing	0	0	0	0	0	0		0	0	0	0	0		0	0	1	0		0	0	0	
Summer	I ask for help from the lecturer during class	2	2	1	5	8	6		4	3	5	13	11		10	7	5	3		0	2	0	
	I ask for help from a friend during class	0	1	1	2	3	1		1	2	2	12	7		5	5	1	3		0	1	0	
	I ask for help from the lecturer after class	0	1	0	2	5	1		1	2	1	4	3		1	1	1	2		0	1	0	
	I ask for help from a friend after class	2	2	0	4	2	0		0	1	2	4	2		2	0	2	2		0	0	0	
	I look the topic up in a text book	2	0	1	3	4	1		1	1	1	5	6		3	0	2	0		0	2	0	
	I ask for help from a relative	0	0	0	2	0	1		0	1	0	2	2		1	0	2	1		0	0	0	
	I do nothing	0	0	0	1	0	0		0	0	0	0	0		0	0	1	0		0	0	0	

Table D.45: Actions Undertaken

Survey 2 Question 14 and Survey 3 Question 30
I needed support in the following lessons: Which lesson topics required extra support?

04/05
Term 2 *N* = 107
05/06
Term 2 *N* = 118

Term Time	**Category**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	Powers & indices	-	-	2	4	4	1		0	0	0	4	9		1	0	2	0		0	0	0	
	Simplifying expressions	-	-	3	4	1	1		0	0	1	2	8		0	0	2	0		0	0	0	
	Solving equations	-	-	0	4	1	0		0	0	1	2	8		0	0	2	0		0	1	0	
	Transpositions	-	-	5	3	1	0		0	2	3	4	9		0	0	3	0		0	4	0	
	Simultaneous equations	-	-	2	4	3	1		0	1	1	3	10		2	0	2	0		0	2	0	
	Surface areas	-	-	0	2	1	1		0	1	1	3	7		1	0	1	0		0	2	0	
	Volumes	-	-	0	2	1	1		1	0	2	3	7		0	0	1	0		0	1	0	
	Trigonometry & Pythagoras	-	-	1	1	1	0		0	0	1	2	6		0	0	4	0		0	2	0	
	Circular Measure	-	-	0	2	1	0		0	0	2	4	8		0	0	2	0		0	2	0	
	Algebraic graphs	-	-	3	2	3	1		1	0	1	1	8		1	0	3	0		0	1	0	
	Simultaneous graphs	-	-	2	2	3	1		0	0	3	1	8		0	0	2	0		0	2	0	
	Trigonometric graphs	-	-	4	2	5	1		0	0	3	1	9		1	0	3	0		0	4	0	
	Waveforms	-	-	1	2	2	1		0	0	2	2	8		2	0	3	0		0	2	0	
	Statistical diagrams	-	-	3	4	0	0		0	0	1	2	7		2	0	2	0		0	5	0	
	Averages	-	-	0	4	0	0		0	0	0	1	7		1	0	2	0		0	2	0	
	Dispersion	-	-	0	4	2	0		0	0	2	2	7		3	0	2	0		0	4	0	

Table D.46: Lessons Requiring Extra Support (Spring)

Survey 2 Question 14 and Survey 3 Question 30
I needed support in the following lessons: Which lesson topics required extra support?

04/05
Term 3 *N* = 112
05/06
Term 3 *N* = 125

Term Time	**Category**	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Summer	Powers & indices	0	1	0	1	0	0		1	0	0	4	1		1	1	3	1		0	0	0	
	Simplifying expressions	0	1	0	0	1	1		0	0	2	2	1		1	0	3	1		0	2	0	
	Solving equations	0	1	0	0	0	0		0	0	1	2	1		1	1	3	0		0	1	0	
	Transpositions	0	2	0	2	0	0		0	0	3	5	1		1	2	4	1		0	2	0	
	Simultaneous equations	0	2	0	3	0	1		0	0	0	2	1		1	1	4	0		0	1	0	
	Surface areas	0	1	0	2	0	1		0	0	1	3	1		0	2	2	0		0	1	0	
	Volumes	0	1	0	2	0	1		0	0	2	2	1		0	1	2	0		0	0	0	
	Trigonometry & Pythagoras	0	1	0	1	0	2		0	1	2	3	1		1	4	3	0		0	2	0	
	Circular Measure	0	1	0	1	0	1		0	1	3	3	2		0	1	3	1		0	0	0	
	Algebraic graphs	1	2	0	2	2	1		0	1	1	2	3		2	3	4	1		0	1	0	
	Simultaneous graphs	1	1	0	1	0	1		0	1	2	1	2		2	0	3	1		0	2	0	
	Trigonometric graphs	1	1	0	1	0	0		0	2	2	2	2		2	0	4	1		0	1	0	
	Waveforms	0	1	0	4	0	0		0	0	2	2	2		1	2	4	0		0	3	0	
	Statistical diagrams	0	1	0	1	2	2		0	1	1	4	1		1	1	2	0		0	1	0	
	Averages	0	1	0	1	1	2		0	0	1	2	1		1	0	1	0		0	3	0	
	Dispersion	0	1	0	2	1	1		0	1	1	2	1		1	1	3	0		0	1	0	
	Polynomial differentiation	1	1	0	4	2	1		0	1	3	2	4		2	0	5	1		0	2	0	
	Exponential differentiation	1	1	0	3	2	2		0	1	2	3	3		2	0	4	0		0	1	0	
	Trigonometric differentiation	1	1	0	4	0	2		0	1	3	2	3		3	1	3	0		0	3	0	
	Differential applications	1	1	0	3	1	2		0	2	3	2	4		2	0	3	0		0	1	0	
	Definite & indefinite integration	1	1	0	6	2	2		1	1	3	3	3		2	1	5	0		0	4	0	
	Area under a curve & differential equations	1	2	0	4	0	2		1	2	2	2	2		2	1	4	0		0	4	0	
	Sine & cosine rules	0	1	0	4	0	1		0	1	3	3	1		2	2	1	1		0	2	0	
	Vectors	0	1	0	4	0	1		0	0	2	3	2		2	1	1	1		0	1	0	
	Algebraic solution of quadratic equations	0	1	0	3	2	0		0	0	2	5	1		2	0	3	0		0	2	0	
	Proportion & exponential graphs	1	1	0	3	0	1		0	1	3	4	3		2	2	2	0		0	2	0	

Table D.47: Lessons Requiring Extra Support (Summer)

Survey 2 Question 15(b)
You indicated that it was easy to get the support you needed in mathematics. What type of support was needed?

04/05 Total *N* = 67
Term 2 *N* = 21
05/06 Total *N* = 76
Term 2 *N* = 36

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunication (FT)		Fabricators (PT)	
Spring	An individual mathematics lesson	-	-	0	2	0	0		2	0	0	1	1		0	0	0	0		0	0	0	
	Parts of an individual mathematics lesson	-	-	3	3	3	0		2	2	1	2	1		0	0	0	0		0	3	0	
	A complete set of mathematics lessons covering a topic area	-	-	0	0	1	0		0	0	1	2	3		0	0	1	0		0	2	0	
	Parts of a complete set of mathematics lessons covering a topic area	-	-	4	1	1	0		1	1	1	1	2		0	0	1	0		0	1	0	
	Background and basic mathematics needed for the course	-	-	0	1	0	1		0	0	1	0	0		1	0	0	0		0	3	0	

Response Rates: 04/05 31% Term 2; 05/06 47% Term 2

Table D.48: Types of Support Required

Survey 2 Question 15(c)
You indicated that it was easy to get the support you needed in mathematics. Why was the support needed?

04/05 Total *N* = 67
Term 2 *N* = 34
05/06 Total *N* = 76
Term 2 *N* = 48

Term Time	Category	Operations & Maintenance (PT)		Electrical & Electronic Group A (PT)		Electrical & Electronic Group B (PT)		Electrical & Electronic Group C (PT)		Mechanical Group A (PT)		Mechanical Group B (PT)		Mechanical Group C (PT)		Manufacturing Group A (FT)		Manufacturing Group B (FT)		Telecommunications (FT)		Fabricators (PT)	
Spring	To cover work I had missed	-	-	0	0	1	1		1	0	1	1	1		1	0	0	0		0	2	0	
	To cover work I didn't understand	-	-	6	3	5	0		3	2	3	3	6		1	0	1	0		0	2	0	
	To remind me of basic underlying techniques	-	-	4	4	1	1		1	0	0	5	3		0	0	1	0		0	4	0	
	To revise for exams	-	-	1	2	2	0		0	2	2	1	2		0	0	0	0		0	1	0	
	Other	-	-	0	0	0	0		0	0	0	0	0		0	0	0	0		0	0	0	

Response Rates: 04/05 51% Term 2; 05/06 63% Term 2

Table D.49: Reasons for Support

E STUDENT PEN PROFILES

Student Number	Academic Year	Attendance Mode	Engineering Discipline	Qualifications	VLE Use	Result	Other Information
1	04/05	Part Time	Electrical/Electronic	Q inc Maths C+	None	Pass	16yr old male apprentice
2	05/06	Part Time	Electrical/Electronic	Q inc Maths C+	None	Fail	16yr old male apprentice
3	05/06	Part Time	Mechanical	NQ no Maths C+	None	Fail	16yr old male apprentice
4	04/05	Part Time	Electrical/Electronic	Q inc Maths C+	User	Fail	17yr old male apprentice
5	05/06	Part Time	Electrical/Electronic	NQ no Maths C+	User	Pass	16yr old male apprentice
6	05/06	Full Time	Telecommunications	Q inc Maths C+	None	Distinction	18yr old male
7	04/05	Full Time	Manufacturing	Q inc Maths C+	User	Pass	16yr old male apprentice
8	05/06	Full Time	Manufacturing	Q inc Maths C+	User	Pass	16yr old male
9	04/05	Part Time	Fabrication	Q inc Maths C+	None	Pass	17yr old male apprentice
10	05/06	Full Time	Manufacturing	Q inc Maths C+	None	Pass	16yr old male
11	04/05	Full Time	Telecommunications	NQ no Maths C+	User	Pass	18yr old male
12	05/06	Part Time	Electrical/Electronic	NQ no Maths C+	User	Pass	30yr old male
13	04/05	Full Time	Manufacturing	NQ no Maths C+	None	Pass	16yr old male
14	05/06	Part Time	Mechanical	NQ no Maths C+	None	Pass	16yr old male apprentice
15	05/06	Full Time	Manufacturing	Q inc Maths C+	User	Fail	19yr old male
16	05/06	Part Time	Electrical/Electronic	Q inc Maths C+	User	Fail	16yr old male apprentice
17	04/05	Part Time	Mechanical	Q inc Maths C+	None	Fail	17yr old male apprentice
18	05/06	Full Time	Manufacturing	Q inc Maths C+	None	Fail	18yr old male
19	05/06	Full Time	Telecommunications	NQ no Maths C+	User	Fail	17yr old male
20	04/05	Full Time	Telecommunications	NQ no Maths C+	None	Fail	16yr old male
21	05/06	Full Time	Telecommunications	NQ no Maths C+	None	Fail	20yr old male
22	04/05	Part Time	Mechanical	Q Entrance Test	User	Pass	24yr old male
23	05/06	Full Time	Telecommunications	NQ no Maths C+	User	Pass	23yr old male
24	05/06	Part Time	Mechanical	Q inc Maths C+	User	Pass	25yr old male
25	05/06	Full Time	Manufacturing	NQ no Maths C+	User	Pass	16yr old dyslexic female
26	05/06	Part Time	Electrical/Electronic	Q inc Maths C+	User	Distinction	32yr old male
27	05/06	Part Time	Operations & Maintenance	NQ no Maths C+	User	Pass	34yr old dyslexic male
28	04/05	Full Time	Telecommunications	NQ no Maths C+	User	Fail	17yr old male
29	04/05	Full Time	Manufacturing	Q inc Maths C+	None	Fail	18yr old male
30	04/05	Full Time	Manufacturing	Q inc Maths C+	User	Fail	17yr old male

F STATISTICAL TESTING TABLES

All of the questionnaires are included in Appendix B. The coding gives the questionnaire and the specific question. For example, S2q5 means Survey 2, question 5. The S value relates to which survey was used – term 1, term 2, or term 3. The q value relates the actual question on that particular survey. Where the questions are split into parts in the questionnaire, (sometimes specifically labelled and other times not, depending upon context), for data logging purposes these were further broken down by (i) use of lower case letters; e.g. S1q14c would be Survey 1, question 14, but specifically the third part of the question; and (ii) use of lower case letters and numbers; e.g. S1q12a2 would be Survey 1, question 12 and the choice of the second option box. The statistical results considered are highlighted in blue with the most relevant shaded in red.

When the Kruskal-Wallis Test was used, further information could be found by looking at the mean rankings. By looking at the mean rankings for each of the individual questions it was possible to get an idea of how the different disciplines compared. For the choices questions the mean rankings gave the order of magnitude for the selection, but with the Likert scales the rankings related to the magnitude of the scale. The extreme higher end values from the Likert scales have been highlighted in any tables, whilst the highest ranked choice has been italicised. This method of ranking was also used for the Friedman Test results, but an indicator arrow has also been included.

For the Mann-Whitney U Test and Kruskal-Wallis Tests, some of the significant results were not unique to one specific test. These significant results were repeated in several of the other tables which represented different distributions of students. Where these results were repeated across the tables, they were shaded to show the amount of repetition more easily. The results that only occurred in one table were left unshaded, as these were unique to that particular test. The key, which has been used, was white for unique, green for part/full time and discipline, purple for part/full time and group, orange for discipline and group, and yellow for all three. There were also some significant results which were not unique to either the Wilcoxon Matched Pairs Rank Order Test or the Friedman Test. Both of these tests were used to make comparisons over periods of time. These tables were also amended to show which values were unique by shading all non-unique survey/question codes. The key used was white for unique and yellow for both.

Ability

Substantive Hypothesis – Ability
The perceived ability of the engineering student affects their learning of mathematics and ICT.
Research Hypotheses – Ability
The perceived ability of the engineering student regards their learning of mathematics and ICT is affected by their mode of attendance, their engineering discipline and their engineering tutor group.
Experimental Hypotheses – Ability
• The perceived ability of the engineering student to remember mathematics is affected by their mode of attendance, their engineering discipline and their engineering tutor group. • The perceived ability of the engineering student to learn new topics in mathematics is affected by their mode of attendance, their engineering discipline and their engineering tutor group. • The perceived ability of the engineering student in mathematics and ICT generally is affected by their mode of attendance, their engineering discipline and their engineering tutor group. • The perceived ability of the engineering student to have fewer difficulties in mathematics is affected by their mode of attendance, their engineering discipline and their engineering tutor group.
Alternative Hypotheses – Ability
• The perceived ability to remember mathematics is better for the full time engineering students than the part time engineering students, is better for the manufacturing students rather than the other engineering disciplines, and is better for the telecommunications group of students rather than the other engineering tutor groups. • The perceived ability to learn new topics in mathematics makes it easier for the full time engineering students than the part time engineering students, makes it easier for the manufacturing students rather than the other engineering disciplines, and makes it easier for the telecommunications group of students rather than the other engineering tutor groups. • The perceived ability in both mathematics and ICT is higher for the full time engineering students than the part time engineering students, is higher for the manufacturing students rather than the other engineering disciplines, and is higher for the telecommunications group of students rather than the other engineering tutor groups. • The perceived ability in mathematics allows for fewer difficulties in mathematics to occur for the full time engineering students than the part time engineering students, for the manufacturing students rather than the other engineering disciplines, and for the telecommunications groups of students rather than the other engineering tutor groups.
Null Hypotheses – Ability
• There is no difference in the perceived ability to remember mathematics between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups. • There is no difference in the perceived ability to learn new topics in mathematics between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups. • There is no difference in the perceived ability in mathematics or ICT between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups. • There is no difference in the perceived ability to have fewer difficulties in mathematics between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups.

Table F.1: Five Levels of Hypotheses used as Basis for Testing (Ability)

Differences between the Full and Part Time Students	Differences between the Engineering Disciplines	Differences between the Tutor Groups
• differences in remembering mathematics, • differences in learning new topics in mathematics regarding the need for a lot of explanation and the need for extra help to understand, • differences in perceived ability in mathematics regarding the rating of their own mathematics ability to others of their own age, • differences in what they would do if they found a topic difficult with regards to getting help from a friend in class, looking up the information in a textbook, and searching the internet for information, • no differences in the perceived ability in ICT.	• differences in their perceived ability in mathematics regarding the rating of their own mathematics ability compared to others of their own age, • differences in their perceived ability in ICT, • differences in what they would do if they found a topic difficult with regards to getting help from a friend in class, looking up the information in a textbook, and searching the internet for information, • differences in learning new topics in mathematics regarding the need for a lot of explanation, extra help to understand, and taking a long time to grasp. The Electrical/Electronic students ranked the highest in terms of ability with the Telecommunications students ranking the lowest. This corresponded to their level of qualifications at the start of the course.	• differences in remembering mathematics, • differences in learning new topics in mathematics regarding taking a long time to grasp, • differences in their perceived ability in mathematics regarding the rating of their own mathematics ability compared to others of their own age, • differences in what they would do if they found a topic difficult with regards to getting help from a friend in class, looking up the information in a text book, and searching the internet for information, • no difference in the perceived ability in ICT. The Manufacturing group B was the lowest ranked in 04/05, but the Mechanical group A, the Electrical/Electronic group B and the Telecommunications group were the lowest ranked in 05/06. The Manufacturing group B was the lowest ranked in 04/05, but the Mechanical group A, the Electrical/Electronic group B and the Telecommunications group were the lowest ranked in 05/06.

Differences between Student Responses in Terms 1 and 3	Differences between Student Responses in Terms 1, 2 and 3
• differences in learning new topics in mathematics regarding taking a long time to grasp, and finding some topics easy and some difficult, • differences in their perceived ability in mathematics regarding the rating of their own mathematics ability as well as compared to others of their own age, • differences in what they would do if they found a topic difficult across all choices except getting help from a friend after class, and searching the internet for information, • differences in their perceived ability in ICT regarding the rating of their own computing abilities compared to others of their own age.	• differences in their perceived ability in mathematics regarding the rating of their own mathematics ability as well as compared to others of their own age. In 05/06 the mathematical ability rating that the students had given themselves reduced each term. The same was also true of the mathematical ability rating the students had given themselves compared to others their own age in both 04/05 and 05/06.

Table F.2: Summary of Statistically Significant Key Points arising from Testing of Ability Hypotheses

Mann-Whitney U SPSS Results	04/05 Difficulties		05/06 Remember	05/06 New Topics		
	S1q12a2	s3q27a5	s2q5	s1q10a5	s1q10a7	s3q28a7
Mann-Whitney U	729.500	75.000	628.000	982.500	1029.500	298.000
Wilcoxon W	1324.500	130.000	2339.000	4063.500	4110.500	1729.000
Z	-2.857	-2.621	-1.984	-3.043	-3.052	-2.078
Asymp. Sig. (2-tailed)	.004	.009	.047	.002	.002	.038

Mann-Whitney U SPSS Results	05/06 Mathematics Generally			05/06 Difficulties	
	s2q3	s3q1	s3q3	s1q12a6	s1q12a7
Mann-Whitney U	566.000	616.000	547.500	1052.500	989.500
Wilcoxon W	2277.000	3101.000	3032.500	4133.500	4070.500
Z	-2.408	-2.093	-2.674	-2.015	-2.158
Asymp. Sig. (2-tailed)	.016	.036	.007	.044	.031

Table F.3: Significant Part Time and Full Time Comparisons (Ability)

Kruskal-Wallis SPSS Results	04/05 Mathematics Generally	04/05 Difficulties				05/06 Difficulties		
	s1q2	S1q12a2	s1q12a5	s3q27a5	s3q27a2	s3q27a3	s3q27a2	s1q12a7
Chi-Square	11.574	11.496	18.704	10.591	27.468	10.137	8.642	13.872
df	5	5	5	3	4	4	3	4
Asymp. Sig.	.041	.042	.002	.014	.000	.038	.034	.008

Kruskal-Wallis SPSS Results	05/06 Mathematics Generally		05/06 ICT Generally		05/06 New Topics		
	S1q1	s1q3	s1q15	s3q9	s1q10a4	s1q10a5	s1q10a7
Chi-Square	12.989	11.910	12.972	9.639	14.852	13.792	16.748
df	4	4	4	4	4	4	4
Asymp. Sig.	.011	.018	.011	.047	.005	.008	.002

Table F.4: Significant Engineering Discipline Comparisons (Ability)

Kruskal-Wallis Discipline	04/05 Maths Generally	04/05 Difficulties				05/06 Difficulties		
	s1q2	s1q12a2	s1q12a5	s3q27a5	s3q27a2	s3q27a3	s3q27a2	s1q12a7
Op & Maintenance	56.80	46.50	*75.00*	*32.00*	8.50	14.50	*62.00*	44.50
Electrical/ Electronic	45.35	*54.54*	47.96	23.56	14.94	28.64	32.14	49.45
Mechanical	54.23	52.83	43.33	19.71	*22.15*	38.07	32.54	55.97
Telecommunications	58.08	47.23	58.92	00.00	00.00	*39.25*	29.00	*71.75*
Manufacturing	38.86	31.57	50.57	13.00	21.70	36.50	29.00	51.77
Fabrication	31.64	34.96	37.00	00.00	00.00			

	05/06 Mathematics Generally		05/06 ICT Generally		05/06 New Topics		
	s1q1	s1q3	s1q15	s3q9	s1q10a4	s1q10a5	s1q10a7
Op & Maintenance	90.71	88.14	92.14	75.36	*68.57*	57.79	59.79
Electrical/Electronic	50.36	47.55	54.03	42.92	53.00	50.00	52.00
Mechanical	53.33	52.63	52.36	48.55	55.87	52.87	52.00
Telecommunications	61.28	58.97	44.75	45.38	53.00	*67.03*	*65.62*
Manufacturing	46.07	57.70	57.43	42.88	53.00	57.27	55.63
Fabrication							

Table F.5: Mean Ranking of Engineering Discipline Comparisons (Ability)

Kruskal-Wallis SPSS Results	04/05 Mathematics Generally	04/05 Difficulties		05/06 Remember	05/06 New Topics		
	s2q1	s1q12a5	s3q27a2	s3q29	s1q10a4	s1q10a7	s3q28a1
Chi-Square	10.992	18.904	13.447	17.422	21.245	16.748	17.008
df	3	7	6	8	8	8	8
Asymp. Sig.	.012	.008	.036	.026	.007	.033	.030

Kruskal-Wallis SPSS Results	05/06 Mathematics Generally			05/06 Difficulties		
	s1q3	s2q3	s3q3	s1q12a2	s1q12a7	s3q27a2
Chi-Square	23.238	18.608	17.746	17.525	21.260	32.843
df	8	7	8	8	8	8
Asymp. Sig.	.003	.010	.023	.025	.006	.000

Table F.6: Significant Engineering Tutor Group Comparisons (Ability)

Kruskal-Wallis Group	04/05 Mathematics Generally	04/05 Difficulties		05/06 Remember	05/06 New Topics		
	s2q1	S1q12a5	s3q27a2	s3q29	s1q10a4	s1q10a7	s3q28a1
Operations & Maintenance	- - -	*75.00*	6.50	54.25	*68.57*	59.79	25.00
Electrical & Electronic (A)	27.80	46.50	*25.50*	42.83	53.00	52.00	28.67
Electrical & Electronic (B)	17.04	49.95	13.62	33.0	53.00	52.00	*47.00*
Electrical & Electronic (C)				14.42	53.00	52.00	30.50
Mechanical (A)	13.75	43.79	16.00	40.20	53.00	52.00	25.00
Mechanical (B)	24.71	42.94	24.04	31.88	53.00	52.00	32.62
Mechanical (C)				27.55	62.08	52.00	44.80
Telecommunications	00.00	58.92	00.00	37.50	53.00	*65.62*	25.00
Manufacturing (A)	00.00	50.57	20.07	31.44	53.00	55.63	32.33
Manufacturing (B)	00.00	00.00	*25.50*				
Fabrication	00.00	37.00	00.00				

	05/06 Mathematics Generally			05/06 Difficulties		
	s1q3	s2q3	s3q3	s1q12a2	s1q12a7	s3q27a2
Operations & Maintenance	88.14	- - -	48.50	48.86	44.50	*62.00*
Electrical & Electronic (A)	42.50	31.59	40.60	*76.37*	48.13	32.67
Electrical & Electronic (B)	64.25	44.00	58.21	52.75	44.50	34.50
Electrical & Electronic (C)	41.75	34.28	34.75	47.30	55.40	29.00
Mechanical (A)	73.95	68.50	64.67	36.40	55.40	42.20
Mechanical (B)	41.41	34.03	33.33	62.97	64.94	31.54
Mechanical (C)	49.83	39.19	44.10	48.21	44.50	29.00
Telecommunications	58.97	48.21	63.04	56.16	*71.75*	29.00
Manufacturing (A)	57.70	56.36	56.33	50.93	51.77	29.00
Manufacturing (B)						
Fabrication						

Table F.7: Mean Ranking of Engineering Tutor Group Comparisons (Ability)

Wilcoxon SPSS Results	**04/05 Mathematics Generally**		**04/05 ICT Generally**	**05/06 New Topics**	
	s3q1 - s1q1	s3q3 – s1q3	s3q11 – s1q17	s3q28a3 – s1q10a3	s3q28a4 – s1q10a4
Z	-2.538[a]	-3.402[a]	-2.075[a]	-1.964[a]	-2.646[b]
Asymp. Sig. (2-tailed)	.011	.001	.038	.050	.008

Wilcoxon SPSS Results	**05/06 Mathematics Generally**		**05/06 Difficulties**		
	s3q1 – s1q1	s3q3 – s1q3	s3q25a1 – s1q12a1	s3q25a2 – s1q12a2	s3q25a3 – s1q12a3
Z	-3.925[a]	-3.212[a]	-4.642[a]	-4.004[a]	-2.400[a]
Asymp. Sig. (2-tailed)	.000	.001	.000	.000	.016

Wilcoxon SPSS Results	**05/06 Difficulties (contd)**			
	s3q25a5 – s1q12a5	s3q25a6 – s1q12a6	s3q25a7 – s1q12a7	s3q25a8 – s1q12a8
Z	-3.411[a]	-4.849[b]	-3.272[b]	-3.873[b]
Asymp. Sig. (2-tailed)	.001	.000	.001	.000

a: Based on positive ranks b: Based on negative ranks

Table F.8: Significant Initial and Final Questionnaire Comparisons (Ability)

Friedman SPSS Results	04/05 Mathematics Generally			05/06 Mathematics Generally					
	s1q3/s2q3/s3q3	Mean Rank		s1q1/s2q1/s3q1	Mean Rank		s1q3/s2q3/s3q3	Mean Rank	
Chi-Square	11.839	s1q3	2.33	11.225	s1q1	2.22	6.837	s1q3	2.17
df	2.000	s2q3	1.86	2.000	s2q1	1.98	2.000	s2q3	1.94
Asymp. Sig.	.003	s3q3	1.80	.004	s3q1	1.80	.033	s3q3	1.89

Table F.9: Significant Three Way Questionnaire Comparisons (Ability)

Attitude

Substantive Hypothesis – Attitude

The attitude of the engineering student affects their learning of mathematics and ICT.

Research Hypotheses – Attitude

The attitude of the engineering student towards their learning of mathematics and ICT is affected by their mode of attendance, is affected by their engineering discipline, and is affected by their engineering tutor group.

Experimental Hypotheses – Attitude

- The attitude of the engineering student towards reviewing mathematics is affected by their mode of attendance, their engineering discipline, and their engineering tutor group.
- The attitude of the engineering student towards practising mathematics is affected by their mode of attendance, their engineering discipline, and their engineering tutor group.
- The attitude of the engineering student towards revising mathematics is affected by their mode of attendance, their engineering discipline, and their engineering tutor group.
- The attitude of the engineering student towards mathematics and ICT generally is affected by their mode of attendance, their engineering discipline, and their engineering tutor group.
- The attitude of the engineering student towards absence and catching up of work in mathematics is affected by their mode of attendance, their engineering discipline, and their engineering tutor group.
- The attitude of the engineering student towards using the internet is affected by their mode of attendance, their engineering discipline, and their engineering tutor group.

Alternative Hypotheses – Attitude

- The attitude to reviewing mathematics is better for the full time engineering students than the part time engineering students, better for the manufacturing students rather than the other engineering disciplines, and better for the telecommunications group of students rather than the other engineering tutor groups.
- The attitude to practising mathematics is better for the full time engineering students than the part time engineering students, better for the manufacturing students rather than the other engineering disciplines, and better for the telecommunications group of students rather than the other engineering tutor groups.
- The attitude to revising mathematics is better for the full time engineering students than the part time engineering students, better for the manufacturing students rather than the other engineering disciplines, and better for the telecommunications group of students rather than the other engineering tutor groups.
- The attitude to mathematics and ICT generally is better for the full time engineering students than the part time engineering students, better for the manufacturing students rather than the other engineering disciplines, and better for the telecommunications groups of students rather than the other engineering tutor groups.
- The attitude to absence and catching up of work in mathematics is better for the full time engineering students than the part time engineering students, better for the manufacturing students rather than the other engineering disciplines, and better for the telecommunications groups of students rather than the other engineering tutor groups.
- The attitude to using the internet is better for the full time engineering students than the part time engineering students, better for the manufacturing students rather than the other engineering disciplines, and better for the telecommunications groups of students rather than the other engineering tutor groups.

Null Hypotheses – Attitude

- There is no difference in the attitude to reviewing mathematics between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups.
- There is no difference in the attitude to practising mathematics between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups.
- There is no difference in the attitude to revising mathematics between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups.
- There is no difference in the attitude to mathematics and ICT generally between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups.
- There is no difference in the attitude to absence and catching up of work in mathematics between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups.
- There is no difference in the attitude to using the internet between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups.

Table F.10: Five Levels of Hypotheses used as Basis for Testing (Attitude)

Differences between the Full and Part Time Students	Differences between the Engineering Disciplines	Differences between the Tutor Groups
• differences in attitude towards mathematics regarding its importance, and how well it is liked, • differences in attitude towards requiring support, • differences in attitude towards absence and catching up work regarding needing extra help to understand, copying notes from a friend, finding it difficult to catch up, asking a friend to explain, and using textbooks, • differences in practising mathematics regarding asking someone to help, using textbooks, using revisions sheets and using the internet, • differences in attitude towards ICT regarding its importance and how well it is liked, • differences in using the internet regarding learning mathematics, and using especially written resources, • differences in having used and heard about the Blackboard mathematical resources, • differences in revising mathematics by using class notes, class worksheets, and getting extra help.	• differences in reviewing mathematics regarding revision, and after lessons, • differences in practising mathematics regarding using class notes, and using the internet, • differences in attitude towards both mathematics support and ICT support and their importance, • differences in attitude towards liking ICT, • differences in catching up regarding missing lessons, and using textbooks, • differences in having used and heard about the Blackboard mathematical resources, • differences in revising mathematics by using class notes, class worksheets, and getting extra help. The Operations and Maintenance, and Mechanical groups show the lowest ranking on attitudes to ICT, whilst the Manufacturing and Telecommunications groups show the lowest ranking on attitudes to mathematics.	• differences in reviewing mathematics after lessons, • differences in practising mathematics using worksheets, and using the internet, • differences in attitude towards liking mathematics and ICT, • differences in attitude towards mathematics support and its importance, • differences in their attitude towards missing lessons regarding ease of catching up, not missing lessons, and needing extra help to understand, • differences in using the internet regarding learning mathematics, and using specifically written resources, • differences in having used and heard about the Blackboard mathematical resources, • differences in revising mathematics by using class worksheets. The lowest ranking attitudes for mathematics are from the Electrical/Electronic group A and for ICT from the Mechanical group B.

Differences between Student Responses in Terms 1 and 3	Differences between Student Responses in Terms 1, 2 and 3
• differences in the attitude towards requiring support in mathematics, • differences in the attitude towards the importance of ICT, • differences in using the internet for specifically written materials, • differences in practising mathematics regarding asking someone for help, using the internet, and using class notes, • differences when missing lessons regarding needing extra help to understand, having difficulty catching up, and using textbooks.	• differences in the attitude towards requiring support in mathematics, • differences in the attitude towards the importance of ICT, • differences in using the internet for specifically written materials. In 04/05 the attitude rating towards needing support in mathematics the students had given themselves reduced each term. The same was also true of the attitude rating the students had given themselves towards learning mathematics via the internet in 05/06, so that they became less negative towards the idea. The attitude rating towards needing support in using computers the students had given themselves reduced from term 1 to term 2 but then increased from term 2 to term 3 and finished higher than it started.

Table F.11: Summary of Statistically Significant Key Points arising from Testing of Attitude Hypotheses

Mann-Whitney U SPSS Results	04/05 Mathematics Generally		04/05 Absence Catch up		05/06 Practice			
	s1q13b	s3q4b	s3q25a3	s3q25a6	s1q19a2	s1q19a6	s3q23a1	s3q23a4
Mann-Whitney U	735.000	176.500	85.000	79.000	802.000	981.000	228.500	243.500
Wilcoxon W	1330.000	254.500	140.000	485.000	3883.000	4062.000	319.500	334.500
Z	-2.450	-2.015	-2.320	-2.364	-3.534	-1.960	-2.185	-2.046
Asymp. Sig. (2-tailed)	.014	.044	.020	.018	.000	.050	.029	.041
Exact Sig. [2*(1-tailed Sig.)]			.070	.044				

Mann-Whitney U SPSS Results	05/06 Maths Generally	05/06 Absence Catch up				05/06 ICT Generally	
	s2q4c	s1q11a2	s1q11a3	s1q11a4	s1q11a8	s1q14a	s1q14b
Mann-Whitney U	603.500	1060.500	1029.500	1021.500	949.500	758.000	877.500
Wilcoxon W	2314.500	4141.500	4110.500	4102.500	4030.500	1254.000	1373.500
Z	-1.981	-2.208	-3.052	-2.642	-2.140	-3.108	-2.295
Asymp. Sig. (2-tailed)	.048	.027	.002	.008	.032	.002	.022

Mann-Whitney U SPSS Results	05/06 Revise		05/06 Internet			
	s1q9a2	s1q9a4	s1q18a	s2q7a	s2q7b	s2q7c
Mann-Whitney U	792.000	911.500	915.000	588.500	595.000	586.000
Wilcoxon W	1288.000	1407.500	1411.000	994.500	1001.000	992.000
Z	-3.257	-2.827	-2.095	-2.258	-2.332	-2.473
Asymp. Sig. (2-tailed)	.001	.005	.036	.024	.020	.013

Table F.12: Significant Part Time and Full Time Comparisons (Attitude)

Kruskal-Wallis SPSS Results	04/05 Review	04/05 Mathematics Generally			04/05 ICT Generally		04/05 Absence Catch up
	s3q26a3	s1q13c	s2q4c	s3q4c	s2q17c	s3q8c	s1q11a2
Chi-Square	9.236	16.527	8.111	8.136	4.094	8.481	12.184
df	3	5	1	3	1	3	5
Asymp. Sig.	.026	.005	.004	.043	.043	.037	.032

Kruskal-Wallis SPSS Results	05/06 Practice		05/06 Mathematics Generally		05/06 Absence Catch up	
	s1q19a2	s1q19a5	s2q4a	s3q4a	s1q11a3	s1q11a4
Chi-Square	13.833	11.655	14.079	11.747	12.224	10.415
df	4	4	3	4	4	4
Asymp. Sig.	.008	.020	.003	.019	.016	.034

Kruskal-Wallis SPSS Results	05/06 Review		05/06 Revise		05/06 ICT Generally		05/06 Internet	
	s3q26a2	s3q26a3	s1q9a2	S1q9a4	s1q14a	s2q17b	s2q7b	s2q7c
Chi-Square	27.468	10.137	12.551	13.557	15.091	8.149	26.767	23.641
df	4	4	4	4	4	3	3	3
Asymp. Sig.	.000	.038	.014	.009	.005	.043	.000	.000

Table F.13: Significant Engineering Discipline Comparisons (Attitude)

Kruskal-Wallis	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank
Discipline	**04/05 Review**	**04/05 Mathematics Generally**			**04/05 ICT Generally**		**04/05 Absence Catch up**
	s3q26a3	s1q13c	S2q4c	s3q4c	s2q17c	s3q8c	s1q11a2
Operations & Maintenance	*25.00*	76.10	- - -	43.60	- - -	46.00	*70.50*
Electrical & Electronic	12.33	37.92	18.46	24.08	19.11	25.98	47.48
Mechanical	22.76	58.77	29.56	33.64	26.88	32.48	46.75
Telecommunications	00.00	44.58	00.00	00.00	00.00	00.00	42.00
Manufacturing	19.30	34.86	00.00	25.42	00.00	23.29	48.79
Fabrication	00.00	43.36	00.00	00.00	00.00	00.00	48.70

	05/06 Practice		**05/06 Mathematics Generally**		**05/06 Absence Catch up**		**05/06 Review**	
	s1q19a2	s1q19a5	s2q4a	S3q4a	s1q11a3	s1q11a4	s3q26a2	s3q26a3
Operations & Maintenance	40.00	54.21	- - -	59.79	59.79	50.50	*62.00*	14.50
Electrical & Electronic	49.91	57.05	46.95	52.22	52.00	55.45	32.14	28.64
Mechanical	51.47	57.70	35.67	38.98	52.00	50.50	32.54	38.07
Telecommunications	67.25	*58.59*	35.00	35.67	*62.22*	*64.12*	29.00	*39.25*
Manufacturing	*69.07*	40.20	61.89	61.58	59.27	57.77	29.00	38.50
Fabrication								

	05/06 Revise		**05/06 ICT Generally**		**05/06 Internet**	
	s1q9a2	s1q9a4	s1q14a	s2q17b	s2q7b	s2q7c
Operations & Maintenance	*62.14*	58.71	72.71	- - -	- - -	- - -
Electrical & Electronic	60.73	54.94	59.68	40.73	34.21	35.43
Mechanical	59.68	*62.20*	59.63	47.82	*59.40*	*58.57*
Telecommunications	48.03	52.88	29.38	29.86	40.36	35.43
Manufacturing	34.63	37.43	52.27	53.43	31.14	35.43
Fabrication						

Table F.14: Mean Ranking of Engineering Discipline Comparisons (Attitude)

Kruskal-Wallis SPSS Results	**04/05 Mathematics Generally**			**04/05 Absence Catch up**			**04/05 Internet**	**05/06 Absence Catch up**	**05/06 Revise**
	s1q13c	s2q4a	s2q4c	s1q4	s1q11a2	s3q25a3	s2q6a	s1q11a1	s1q9a2
Chi-Square	17.366	10.516	11.007	14.419	14.652	12.829	13.235	16.273	31.352
Df	7	3	3	7	7	6	3	8	8
Asymp. Sig.	.015	.015	.012	.044	.041	.046	.004	.039	.000

Kruskal-Wallis SPSS Results	**05/06 ICT Generally**	**05/06 Review**		**05/06 Internet**		
	s1q14a	s1q8a2	s3q26a2	s1q20	s2q7b	s2q7c
Chi-Square	15.957	20.715	32.843	16.325	30.635	25.727
df	8	8	8	8	7	7
Asymp. Sig.	.043	.008	.000	.038	.000	.001

	05/06 Practice		**05/06 Mathematics Generally**		
Kruskal-Wallis SPSS Results	s1q19a2	s1q19a3	s1q13a	s2q4a	s3q4a
Chi-Square	18.986	17.481	16.054	18.412	18.929
Df	8	8	8	7	8
Asymp. Sig.	.015	.025	.042	.010	.015

Table F.15: Significant Engineering Tutor Group Comparisons (Attitude)

Kruskal-Wallis	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank
Group	**04/05 Mathematics Generally**			**04/05 Absence Catch up**			**04/05 Internet**
	s1q13c	S2q4a	S2q4c	s1q4	s1q11a2	s3q25a3	s2q6a
Operations & Maintenance	76.10	- - -	- - -	*64.60*	*70.50*	14.00	- - -
Electrical & Electronic (A)	38.60	30.67	14.77	41.67	51.50	*33.00*	26.97
Electrical & Electronic (B)	37.00	18.04	22.73	36.59	42.00	21.12	14.15
Electrical & Electronic (C)							
Mechanical (A)	63.46	15.25	30.62	37.68	45.39	14.00	16.12
Mechanical (B)	54.66	19.54	29.21	63.31	47.94	24.23	*28.08*
Mechanical (C)							
Telecommunications	44.58	00.00	00.00	49.58	42.00	00.00	00.00
Manufacturing (A)	34.86	00.00	00.00	45.43	48.79	14.00	00.00
Manufacturing (B)	00.00	00.00	00.00	00.00	00.00	14.00	00.00
Fabrication	43.36	00.00	00.00	50.46	48.79	00.00	00.00
	05/06 ICT Generally	**05/06 Review**		**05/06 Absence Catch up**	**05/06 Revise**	**05/06 Practice**	
	s1q14a	s1q8a2	s3q26a2	s1q11a1	s1q9a2	s1q19a2	s1q19a3
Operations & Maintenance	72.71	63.36	*62.00*	56.36	62.14	40.00	51.64
Electrical & Electronic (A)	56.70	*69.07*	32.67	*72.97*	74.60	58.17	*71.37*
Electrical & Electronic (B)	66.38	53.62	34.50	46.62	51.44	40.00	34.12
Electrical & Electronic (C)	59.95	45.45	29.00	60.25	47.35	45.45	42.30
Mechanical (A)	58.90	40.00	42.20	49.35	58.25	50.90	53.20
Mechanical (B)	62.31	63.84	31.54	63.66	*75.28*	57.03	64.78
Mechanical (C)	56.67	44.54	29.00	46.62	40.08	44.54	56.83
Telecommunications	29.38	63.84	29.00	39.81	48.03	67.25	57.97
Manufacturing (A)	52.27	43.63	29.00	54.80	34.63	*69.07*	45.93
Manufacturing (B)							
Fabrication							
	05/06 Internet			**05/06 Mathematics Generally**			
	s1q20	S2q7b	S2q7c	s1q13a	s2q4a	s3q4a	
Operations & Maintenance	62.14	- - -	- - -	77.93	- - -	59.79	
Electrical & Electronic (A)	41.50	28.91	36.55	55.57	53.82	62.50	
Electrical & Electronic (B)	67.56	35.75	27.75	71.12	51.44	47.93	
Electrical & Electronic (C)	73.65	39.33	40.89	40.30	34.56	39.80	
Mechanical (A)	40.15	53.67	*60.00*	53.80	42.67	49.08	
Mechanical (B)	55.81	*65.31*	*60.00*	36.03	34.31	31.60	
Mechanical (C)	61.54	51.88	54.62	56.92	33.12	44.00	
Telecommunications	42.72	40.36	35.43	54.81	35.00	35.67	
Manufacturing (A)	62.93	31.14	35.43	64.63	61.89	61.58	
Manufacturing (B)							
Fabrication							

Table F.16: Mean Ranking of Engineering Tutor Group Comparisons (Attitude)

Wilcoxon SPSS Results	04/05 Practice	04/05 Mathematics Generally	04/05 Absence Catch up	05/06 Absence Catch up		
	s3q23a6 – s1q19a6	s3q4c – s1q13c	s3q25a3 – s1q11a3	s3q25a2 – s1q11a2	s3q25a3 – s1q11a3	s3q25a4 – s1q11a4
Z	-2.840[a]	-2.250[a]	-2.887[a]	-2.121[b]	-2.121[b]	-2.121[b]
Asymp. Sig. (2-tailed)	.005	.024	.004	.034	.034	.034

Wilcoxon SPSS Results	05/06 Internet	05/06 Practice		05/06 ICT Generally
	s2q7a – s1q20	s3q23a2 – s1q19a2	s3q23a5 – s1q19a5	s3q8b – s1q14b
Z	-2.227[b]	-2.236[b]	-3.357[a]	-2.398[a]
Asymp. Sig. (2-tailed)	.026	.025	.001	.016

a: Based on positive ranks b: Based on negative ranks

Table F.17: Significant Initial and Final Questionnaire Comparisons (Attitude)

Friedman SPSS Results	04/05 Mathematics Generally			05/06 ICT Generally			05/06 Internet		
	s1q13c s2q4c s3q4c		Mean Rank	s1q14c s2q17c s3q8c		Mean Rank	s1q18a s2q6a s3q24		Mean Rank
Chi-Square	7.187	s1q13c	2.29	7.031	s1q14c	2.08	24.431	s1q18a	2.26
df	2.000	s2q4c	1.97	2.000	s2q17c	1.79	2.000	s2q6a	2.16
Asymp. Sig.	.028	s3q4c	1.74	.030	s3q8c	2.13	.000	s3q24	1.58

Table F.18: Significant Three Way Questionnaire Comparisons (Attitude)

VLE Issues

Substantive Hypothesis – VLE Issues
The use of the VLE materials affects the engineering student's learning of mathematics.
Research Hypotheses – VLE Issues
The use of the VLE materials for mathematics by the engineering student is affected by their mode of attendance, by their engineering discipline, and by their engineering tutor group.
Experimental Hypotheses – VLE Issues
• The accessibility to the VLE materials for mathematics by the engineering student is affected by their mode of attendance, by their engineering discipline, and by their engineering tutor group. • The use of the VLE materials for mathematics by the engineering student is affected by their mode of attendance, by their engineering discipline, and by their engineering tutor group. • The recommendations for the VLE materials for mathematics by the engineering student are affected by their mode of attendance, by their engineering discipline, and by their engineering tutor group.
Alternative Hypotheses – VLE Issues
• The access of the VLE materials was easier for the full time engineering students than the part time engineering students, the manufacturing students than the other engineering disciplines, and the telecommunications group of students than the other engineering tutor groups. • The use of the VLE materials was more frequent for the full time engineering students than the part time engineering students, the manufacturing students than the other engineering disciplines, and the telecommunications group of students than the other engineering tutor groups. • The recommendations made for the VLE materials were more general for the full time engineering students than the part time engineering students, the manufacturing students than the other engineering disciplines, and the telecommunications group of students than the other engineering tutor groups.
Null Hypotheses – VLE Issues
• There is no difference in the access of the VLE materials between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups. • There is no difference in the use of the VLE materials between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups. • There is no difference in the recommendations made for the VLE materials between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups.

Table F.19: Five Levels of Hypotheses used as Basis for Testing (VLE Issues)

Differences between the Full and Part Time Students	Differences between the Engineering Disciplines	Differences between the Tutor Groups
• differences in accessibility of the VLE by time of day, computer availability, ease of finding lessons, having heard of Blackboard , and used Blackboard resources, • differences in use of VLE regarding time spent, time of day, and frequency.	• differences in the accessibility of the VLE by computer availability, ease of finding lessons on the VLE, having heard of Blackboard , and having used Blackboard resources, • differences in the use of the VLE regarding time spent, and frequency of use. The Mechanical students ranked the lowest for use of the VLE.	• differences in the accessibility of the VLE by venue, ease of finding lessons, having heard of Blackboard, and used of the Blackboard resources, • differences in the use of the VLE regarding time spent, and frequency of use. The Mechanical groups B and C were the lowest ranked for using the VLE.

Table F.20: Summary of Statistically Significant Key Points arising from Testing of VLE Issues Hypotheses

Mann-Whitney U SPSS Results	**04/05 Access**		**05/06 Access**				**05/06 Usage**	
	s3q14c	s3q6	s3q14b1	s3q14b3	s3q6	s3q5	s2q7b	S3q13a
Mann-Whitney U	8.500	164.000	41.500	52.500	491.500	505.000	595.000	659.000
Wilcoxon W	11.500	1245.000	107.500	205.500	791.500	805.000	1001.000	959.000
Z	-2.915	-2.331	-2.852	-2.322	-3.215	-3.161	-2.332	-1.981
Asymp. Sig. (2-tailed)	.004	.020	.004	.020	.001	.002	.020	.048
Exact Sig. [2*(1-tailed Sig.)]	.292		.013	.053				

Table F.21: Significant Part Time and Full Time Comparisons (VLE Issues)

Kruskal-Wallis SPSS Results	**04/05 Access**	**05/06 Access**			**05/06 Usage**	
	s3q14c	s3q6	s3q5	s3q14b1	s2q7b	s3q13a
Chi-Square	8.500	26.647	29.165	9.714	26.767	14.666
df	3	4	4	4	3	4
Asymp. Sig.	.037	.000	.000	.046	.000	.005

Table F.22: Significant Engineering Discipline Comparisons (VLE Issues)

Kruskal-Wallis	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank
Discipline	**04/05 Access**	**05/06 Access**			**05/06 Usage**	
	s3q14c	s3q6	s3q5	s3q14b1	s2q7b	s3q13a
Operations & Maintenance	*10.50*	40.14	36.21	17.83	- - -	41.36
Electrical & Electronic	*10.50*	42.36	42.27	18.68	34.21	45.34
Mechanical	*10.50*	85.71	66.26	13.17	*59.40*	*58.95*
Telecommunications	00.00	26.67	27.17	*19.25*	40.38	30.17
Manufacturing	5.75	39.29	39.92	8.50	31.14	49.75
Fabrication	00.00					

Table F.23: Mean Ranking of Discipline Comparisons (VLE Issues)

Kruskal-Wallis SPSS Results	**04/05 Access**	**04/05 Usage**	**05/06 Access**			**05/06 Usage**	
	s3q14c	s3q12	s3q6	s2q11a1	s3q5	s2q7b	s3q13a
Chi-Square	18.000	15.372	29.852	12.263	31.956	30.635	17.053
Df	5	6	8	4	8	7	8
Asymp. Sig.	.003	.018	.000	.015	.000	.000	.030

Table F.24: Significant Tutor Group Comparisons (VLE Issues)

Kruskal-Wallis	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank
Group	**04/05 Access**	**04/05 Usage**	**05/06 Access**			**05/06 Usage**	
	s3q14c	s3q12	S3q6	s2q11a1	s3q5	s2q7b	s3q13a
Operations & Maintenance	*10.50*	21.60	40.14	- - -	36.21	- - -	41.36
Electrical & Electronic (A)	*10.50*	18.29	42.03	8.50	42.43	28.91	42.70
Electrical & Electronic (B)	*10.50*	27.85	47.64	15.50	46.71	35.75	54.79
Electrical & Electronic (C)			39.15	*20.50*	38.90	39.33	42.70
Mechanical (A)	10.50	24.50	51.58	00.00	54.00	53.67	53.67
Mechanical (B)	00.00	*39.00*	66.17	00.00	66.00	*65.31*	55.23
Mechanical (C)			73.50	00.00	74.00	51.88	*61.50*
Telecommunications	00.00	00.00	26.67	11.93	27.17	40.36	30.17
Manufacturing (A)	1.00	35.38	39.29	*20.50*	39.92	31.14	49.75
Manufacturing (B)	*10.50*	31.75					
Fabrication	00.00	00.00					

Table F.25: Mean Ranking of Tutor Group Comparisons (VLE Issues)

Neither the Wilcoxon Matched Pairs Signed Rank Test for comparing Terms 1 and 3, nor the Friedman Test for comparing Terms 1, 2 and 3 produced significant results for any of the null hypotheses with regards to VLE issues.

Support

Substantive Hypothesis – Support
The preferred form of support for the engineering student affects their learning of mathematics.
Research Hypotheses – Support
The preferred form of support in mathematics for the engineering student is affected by their mode of attendance, by their engineering discipline, and by their engineering tutor group.
Experimental Hypotheses – Support
• The choice of preferred form of support in mathematics for the engineering student is affected by their mode of attendance, by their engineering discipline, and by their engineering tutor group. • The use of mathematics replays and support in mathematics for the engineering student is affected by their mode of attendance, by their engineering discipline, and by their engineering tutor group. • The perceived understanding of mathematics for the engineering student is affected by their mode of attendance, by their engineering discipline, and by their engineering tutor group. • The topic areas requiring support in mathematics for the engineering student is affected by their mode of attendance, by their engineering discipline, and by their engineering tutor group. • The preferred method for learning mathematics for the engineering student is affected by their mode of attendance, by their engineering discipline, and by their engineering tutor group.
Alternative Hypotheses – Support
• The choice of mathematics support is more tutor-based for the full time engineering students than the part time engineering students, the manufacturing students than the other engineering disciplines, and the telecommunications group of students than the other engineering tutor groups. • The use of mathematics replays and support is greater for the full time engineering students than the part time engineering students, the manufacturing students than the other engineering disciplines, and the telecommunications group of students than the other engineering tutor groups. • The perceived understanding of mathematics is greater for the full time engineering students than the part time engineering students, the manufacturing students than the other engineering disciplines, and the telecommunications group of students than the other engineering tutor groups. • There are more mathematics topic areas requiring support for the full time engineering students than the part time engineering students, the manufacturing students than the other engineering disciplines, and the telecommunications group of students than the other engineering tutor groups. • The preferred choice of methods for learning mathematics is greater for the full time engineering students than the part time engineering students, the manufacturing students than the other engineering disciplines, and the telecommunications group of students than the other engineering tutor groups.
Null Hypotheses – Support
• There is no difference in the choice of mathematics support between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups. • There is no difference in the use of mathematics replays and support between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups. • There is no difference in the perceived understanding of mathematics between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups. • There is no difference in the mathematics topic areas requiring support between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups. • There is no difference in the choice of methods for learning mathematics between the full time engineering students and the part time engineering students, between the manufacturing students and the other engineering disciplines, and between the telecommunications group of students and the other engineering tutor groups.

Table F.26: Five Levels of Hypotheses used as Basis for Testing (Support)

Differences between the Full and Part Time Students	Differences between the Engineering Disciplines	Differences between the Tutor Groups
• differences in the use of replays and support to cover work missed, and the accessing of different parts of sets of lessons covering a topic, • differences in the topic areas needing support	• differences in the use of replays and support to cover work missed, individual lessons and parts of individual lessons covering a topic, reminder of basic underlying techniques, • differences in the topic areas needing support. The Operations and Maintenance and Telecommunications students ranked the lowest and needed the most support.	• differences in the use of replays and support to cover work missed, work not understood, as a reminder of basic underlying techniques, parts of individual lessons, and parts of sets of lessons covering a topic, • differences in the topic areas needing support. The Electrical/Electronic Group A and the Telecommunications group ranked the lowest and needed the most support out of the individual groups.

Differences between Student Responses in Terms 1 and 3	Differences between Student Responses in Terms 1, 2 and 3
• differences in the use of replays and support to cover work not understood, and as a reminder of basic underlying techniques, • differences in the reasons for replaying lessons, • differences in the use of the internet for support.	• differences in the use of replays and support to cover work missed. In 05/06 the use of replays to cover work missed increased each term.

Table F.27: Summary of Statistically Significant Key Points arising from Testing of Support Hypotheses

Main Topic Area	Individual Lesson Topics	Replayed	Support needed	Support useful	Blackboard accessed
Shape & Trigonometry	Trigonometry & Pythagoras	Term 2 05/06	Term 2 05/06		Term 3 05/06
	Circular measure				Term 3 05/06
	Surface area				Term 3 05/06
	Volume				Term 3 05/06
Algebra	Simplifying expressions			Term 3 05/06	Term 3 05/06
	Solving equations			Term 3 05/06	
	Simultaneous equations			Term 3 05/06	
	Transpositions		Term 3 05/06		Term 3 05/06
	Algebraic simultaneous equations				Term 3 05/06
Applied Problems	Vectors				Term 3 05/06
	Algebraic solution of quadratic equations				Term 3 05/06
	Proportion & exponential graphs				Term 3 05/06
	Sine and cosine rule				Term 3 05/06
Integration	Definite and indefinite integration			Term 3 05/06	Term 3 05/06
	Area under a curve		Term 3 04/05		Term 3 05/06
	Differential equations		Term 3 05/06		Term 3 05/06
Graphs	Waveforms			Term 3 05/06	Term 3 05/06
	Algebraic graphs				Term 3 05/06
	Trigonometric graphs				Term 3 05/06
Statistics	Averages				Term 3 05/06
	Statistical diagrams				Term 3 05/06

Table F.28: Summary of Significant Support (Part Time/Full Time)

Main Topic Area	Individual Lesson Topics	Replayed	Support needed	Support useful	Blackboard accessed
Shape & Trigonometry	Trigonometry & Pythagoras				Term 3 05/06
	Surface area				Term 3 05/06
	Volume				Term 3 05/06
Algebra	Powers and indices				Term 3 05/06
	Algebraic simultaneous equations				Term 3 05/06
Applied Problems	Vectors				Term 3 04/05
	Algebraic solution of quadratic equations				Term 3 04/05
	Sine and cosine rule				Term 3 05/06
Integration	Definite and indefinite integration				Term 3 05/06
	Area under a curve		Term 3 04/05		
	Differential equations		Term 3 05/06		
Graphs	Waveforms				Term 3 04/05
	Trigonometric graphs	Term 2 04/05			
Statistics	Averages			Term 3 05/06	

Table F.29: Summary of Significant Support (Disciplines)

Main Topic Area	Individual Lesson Topics	Replayed	Support needed	Blackboard accessed
Shape & Trigonometry	Trigonometry & Pythagoras			Term 3 05/06
Algebra	Simplifying expressions	Term 2 04/05	Term 2 05/06	
	Solving equations	Term 2 04/05	Term 2 05/06	
	Powers and indices		Term 2 05/06	
	Transpositions		Term 3 05/06	

Table F.30: Summary of Significant Support (Tutor Groups)

Mann-Whitney U	05/06 Replays					05/06 Topic Areas		
SPSS Results	s3q15b4	s3q15c1	s2q10f8	s2q10c1	s2q10c2	s3q17a4	s2q14a8	s3q17a2
Mann-Whitney U	62.000	56.000	75.000	67.500	52.500	62.000	202.500	56.500
Wilcoxon W	215.000	209.000	195.000	187.500	172.500	215.000	1148.500	209.500
Z	-1.974	-2.084	-2.122	-2.198	-2.878	-1.974	-1.992	-2.447
Asymp. Sig. (2-tailed)	.048	.037	.034	.028	.004	.048	.046	.014
Exact Sig. [2*(1-tailed Sig.)]	.147	.082	.126	.061	.011	.147		.082

Mann-Whitney U	05/06 Topic Areas (contd)							
SPSS Results	s3q17a15	s3q17a21	s3q17a22	s3q17a23	s3q17a24	s3q17a25	s3q17a26	s3q17a5
Mann-Whitney U	53.500	45.000	53.500	65.000	62.000	68.000	65.000	39.500
Wilcoxon W	206.500	198.000	206.500	218.000	215.000	221.000	218.000	192.500
Z	-2.403	-2.819	-2.403	-2.020	-1.974	-2.238	-2.020	-3.244
Asymp. Sig. (2-tailed)	.016	.005	.016	.043	.048	.025	.043	.001
Exact Sig. [2*(1-tailed Sig.)]	.059	.022	.059	.191	.147	.244	.191	.009

Mann-Whitney U	05/06 Topic Areas (contd)							
SPSS Results	s3q17a6	s3q17a7	s3q17a8	s3q17a9	s3q17a10	s3q17a12	s3q17a13	s3q17a14
Mann-Whitney U	39.500	36.500	22.500	53.500	65.000	53.500	62.000	62.000
Wilcoxon W	192.500	189.500	175.500	206.500	218.000	206.500	215.000	215.000
Z	-3.244	-3.229	-4.022	-2.403	-2.020	-2.403	-1.974	-1.974
Asymp. Sig. (2-tailed)	.001	.001	.000	.016	.043	.016	.048	.048
Exact Sig. [2*(1-tailed Sig.)]	.009	.006	.000	.059	.191	.059	.147	.147

Mann-Whitney U	05/06 Topic Areas (contd)						
SPSS Results	s3q30a2	s3q30a3	s3q30a4	s3q30a5	s3q30a13	s3q30a21	s3q30a22
Mann-Whitney U	251.000	264.500	244.000	264.000	224.000	223.000	230.000
Wilcoxon W	1682.000	1695.500	1675.000	1695.000	1655.000	1654.000	1661.000
Z	-2.335	-2.281	-2.232	-1.884	-2.565	-2.300	-2.237
Asymp. Sig. (2-tailed)	.020	.023	.026	.060	.010	.021	.025

Table F.31: Significant Part Time and Full Time Comparisons (Support)

Kruskal-Wallis	04/05 Topic Areas			04/05 Replays		05/06 Replays	
SPSS Results	s2q14a12	s3q17a24	s3q17a25	s1q6c1	s3q17a13	s2q10c2	s1q6c1
Chi-Square	5.213	7.906	7.906	12.466	7.906	8.452	12.466
df	1	3	3	4	3	2	4
Asymp. Sig.	.022	.048	.048	.014	.048	.015	.014

Kruskal-Wallis	05/06 Topic Areas						
SPSS Results	s3q17a1	s3q30a15	s3q17a5	s3q17a6	s3q17a7	s3q17a8	s3q17a21
Chi-Square	9.604	10.833	10.695	12.467	13.907	16.707	10.455
df	4	4	4	4	4	4	4
Asymp. Sig.	.048	.029	.030	.014	.008	.002	.033

Kruskal-Wallis	05/06 Topic Areas (contd)		05/06 Choices	05/06 Support		
SPSS Results	s3q17a23	s3q30a22	s3q16	s2q15b1	s2q15b2	s2q15c3
Chi-Square	9.470	10.331	12.000	9.876	10.421	10.589
df	4	4	4	3	3	3
Asymp. Sig.	.050	.035	.017	.020	.015	.014

Table F.32: Significant Engineering Discipline Comparisons (Support)

Kruskal-Wallis	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank
Discipline	04/05 Topic Areas			04/05 Replays		05/06 Replays	
	s2q14a12	s3q17a24	s3q17a25	s1q6c1	s3q17a13	s2q10c2	s1q6c1
Operations & Maintenance	- - -	*14.83*	*14.83*	*63.50*	*14.83*	- - -	39.50
Electrical & Electronic	*22.63*	8.50	8.50	53.27	8.50	11.50	59.32
Mechanical	16.22	10.88	10.88	38.17	10.88	00.00	50.97
Telecommunications	00.00	00.00	00.00	49.62	00.00	*20.36*	*70.16*
Manufacturing	00.00	8.50	8.50	41.79	8.50	18.75	46.77
Fabrication	00.00	00.00	00.00	55.36	00.00		
	05/06 Support			05/06 Topic Areas			
	s2q15b1	s2q15b2	s2q15c3	s3q17a1	s3q30a15	s3q17a5	s3q17a6
Operations & Maintenance	- - -	- - -	- - -	*23.00*	36.25	10.50	10.50
Electrical & Electronic	*34.62*	34.27	34.42	11.55	32.71	11.77	11.77
Mechanical	26.93	25.37	24.30	9.00	31.54	10.50	10.50
Telecommunications	26.00	*35.50*	*37.50*	16.00	*52.75*	19.25	*21.00*
Manufacturing	26.00	23.50	26.17	18.33	31.67	*19.83*	15.17
Fabrication							
	05/06 Topic Areas (contd)					05/06 Choices	
	s3q17a7	s3q17a8	s3q17a21	s3q17a23	s3q30a22	s3q16	
Operations & Maintenance	14.17	9.50	10.00	12.00	38.50	24.50	
Electrical & Electronic	10.77	10.77	11.27	12.00	33.00	10.59	
Mechanical	9.50	9.50	14.67	16.67	29.07	15.83	
Telecommunications	*21.75*	*21.75*	*20.50*	*19.00*	*55.00*	13.50	
Manufacturing	14.17	18.83	14.67	12.00	36.67	20.17	
Fabrication							

Table F.33: Mean Ranking of Engineering Discipline Comparisons (Support)

Kruskal-Wallis	04/05 Replays				05/06 Support	05/06 Choices
SPSS Results	s2q10b3	s2q10c1	s2q10f2	s2q10f3	s2q15c3	s3q16
Chi-Square	4.000	4.000	4.000	4.000	15.094	14.473
Df	1	1	1	1	7	7
Asymp. Sig.	.046	.046	.046	.046	.035	.043

Kruskal-Wallis	05/06 Replays			05/06 Topic Areas					
SPSS Results	s1q6b4	s1q6c1	s1q6c2	s3q17a7	s3q17a8	s3q30a4	s2q14a1	s2q14a2	s2q14a3
Chi-Square	16.074	16.574	15.871	14.225	17.025	15.646	17.932	16.500	14.781
Df	8	8	8	7	7	8	7	7	7
Asymp. Sig.	.041	.035	.044	.047	.017	.048	.012	.021	.039

Table F.34: Significant Tutor Group Comparisons (Support)

Kruskal-Wallis	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank	Mean Rank
Group	04/05 Replays				05/06 Choices	05/06 Topic Areas	
	s2q10b3	s2q10c1	s2q10f2	S2q10f3	s3q16	s2q14a1	s2q14a2
Operations & Maintenance	- - -	- - -	- - -	- - -	24.50	- - -	- - -
Electrical & Electronic (A)	*5.00*	*5.00*	*5.00*	*5.00*	11.50	*38.67*	*39.17*
Electrical & Electronic (B)	2.50	2.50	2.50	2.50	1.50	34.00	34.50
Electrical & Electronic (C)					11.50	20.00	20.50
Mechanical (A)	00.00	00.00	00.00	00.00	11.50	20.00	25.17
Mechanical (B)	00.00	00.00	00.00	00.00	18.00	35.75	34.50
Mechanical (C)					00.00	23.50	20.50
Telecomms	00.00	00.00	00.00	00.00	13.50	20.00	20.50
Manufacturing (A)	00.00	00.00	00.00	00.00	20.17	29.33	29.83
Manufacturing (B)	00.00	00.00	00.00	00.00			
Fabrication	00.00	00.00	00.00	00.00			

	05/06 Topic Areas (contd)				05/06 Support	05/06 Replays		
	s2q14a3	s3q17a7	s3q17a8	s3q30a4	s2q15c3	s1q6b4	s1q6c1	s1q6c2
Operations & Maintenance	- - -	14.17	9.50	42.50	- - -	54.57	39.50	63.64
Electrical & Electronic (A)	*39.17*	11.83	11.83	33.33	*40.17*	49.90	64.93	*68.83*
Electrical & Electronic (B)	20.50	9.50	9.50	26.00	35.50	45.81	46.31	39.31
Electrical & Electronic (C)	20.50	9.50	9.50	26.00	27.10	55.35	61.30	59.75
Mechanical (A)	25.17	9.50	9.50	*45.80*	21.50	55.35	55.85	48.85
Mechanical (B)	34.50	9.50	9.50	28.54	26.75	*69.66*	46.31	46.12
Mechanical (C)	20.50	00.00	00.00	29.30	21.50	39.00	53.12	41.58
Telecomms	24.50	*21.75*	*21.75*	42.50	37.50	66.25	*70.16*	66.56
Manufacturing (A)	29.83	14.17	18.83	40.67	26.17	49.90	46.77	54.30
Manufacturing (B)								
Fabrication								

Table F.35: Mean Ranking of Tutor Group Comparisons (Support)

Wilcoxon SPSS Results	04/05 Replays		05/06 Choices	05/06 Replays
	s3q15c2 – s1q6c2	s3q15c3 – s1q6c3	s3q7a – s2q16a1	s3q15c3 – s1q6c3
Z	-2.828[a]	-2.449[a]	-2.400[a]	-2.121[a]
Asymp. Sig. (2-tailed)	.005	.014	.016	.034

a: Based on positive ranks b: Based on negative ranks

Table F.36: Significant Initial and Final Questionnaire Comparisons (Support)

Friedman SPSS Results	05/06 Replays			
	s1q6c1/s2q10c1/s3q15c1	Mean Rank		
Chi-Square	8.667	s1q6c1	↑	1.57
df	2.000	s2q10c1		2.11
Asymp. Sig.	0.13	s3q15c1		2.32

Table F.37: Significant Three Way Questionnaire Comparisons (Support)