Evaluating a Virtual Learning Environment in Medical Education

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“man should be master of his environment, not its slave.
That is what freedom means.”

Anthony Eden (1897 - 1977),
speech to the Conservative Party Conference, October 1946.

Declaration

This thesis is by Rachel Helen Ellaway. The work is the candidate's own and has not been submitted for any other degree or professional qualification.

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Abstract

The use of technology-supported teaching and learning in higher education has moved from a position of peripheral interest a few years ago to become a fundamental ingredient in the experience of many if not most students today. A major part of that change has been wrought by the widespread introduction and use of 'virtual learning environments' (VLEs). A defining characteristic of VLEs is that they combine a variety of tools and resources into a single integrated system. To use a VLE is not just to employ a single intervention but to change the very fabric of the students' experience of study and the university. Despite this, much of the literature on VLEs has concentrated on producing typologies by listing and comparing system functions, describing small scale and short duration applications or providing speculative theories and predictions. Little attention has so far been paid to analysing what effects a VLE's use has on the participants and the context of use, particularly across a large group of users and over a substantial period of time.

This work presents the evaluation of a VLE developed and used to support undergraduate medical education at the University of Edinburgh since 1999. This system is called 'EEMeC' and was developed specifically within and in support of its context of use. EEMeC provides a large number of features and functions to many different kinds of user, it has evolved continuously since it was introduced and it has had a significant impact on teaching and learning in the undergraduate medical degree programme (MBChB). In such circumstances evaluation methodologies that depend on controls and single variables are nether applicable or practical.

In order to approach the task of evaluating such a complex entity a multi-modal evaluation framework has been developed based on taking a series of metaphor-informed perspectives derived from the organisational theories of Gareth Morgan(Morgan 1997). The framework takes seven approaches to evaluation of EEMeC covering a range of quantitative and qualitative methodologies. These are combined in a dialectical analysis of EEMeC from these different evaluation perspectives.

This work provides a detailed and multi-faceted account of a VLE-in-use and the ways in which it interacts with its user community in its context of use. Furthermore, the method of taking different metaphor-based evaluation perspectives of a complex problem space is presented as a viable approach for studying and evaluating similar learning support systems. The evaluation framework that has been developed would be particularly useful to those practitioners who have a pressing and practical need for meaningful evaluation techniques to inform and shape how complex systems such as VLEs are deployed and used. As such, this work can provide insights not just into EEMeC, but into the way VLEs are changing the environments and contexts in which they are used across the tertiary sector as a whole.

Chapter 1: Introduction

This thesis reports on a holistic investigation of the virtual learning environment (VLE) that supports medical undergraduates at the University of Edinburgh. This system is called 'EEMeC' (the Edinburgh Electronic Medical Curriculum) and it has been in development and use since 1999. At the time of writing it supports more than 2,000 students and members of staff in a wide range of educational and education-related activities.

There were a number of reasons for undertaking this work. EEMeC was purpose-built within and for the Edinburgh undergraduate medical programme and as such it represented both a substantial investment and an approach that ran counter to prevailing forms of VLE provision which tended to favour institution-wide systems to bespoke implementations. The research was undertaken as a means by which a substantial evidence base regarding what was actually being done within and as a result of EEMeC could be built as a means to evaluate the approaches taken to developing and using the system. Furthermore it was hoped that this evaluation could contribute to the debate among medical schools, VLE developers and their parent institutions as to the best approach to take when organising online support for specific use contexts such as medical education. It was also hoped that the research would assist academically grounded practitioners (both within and beyond the EEMeC user community) to better understand what was being attempted and what had been achieved with EEMeC and how that might inform their own practice.

This research has raised a number of issues, including what constitutes the essence of this virtual learning environment and what approaches might be taken to evaluate it. In pursuing these themes a number of methodological issues are considered. For instance, if, as is demonstrated later, there are many different aspects and dimensions to VLE use then what kinds of methods are appropriate for exploring them and how can conceptually different methods and findings be aggregated to form a coherent view of the system? This led to the consideration of the different kinds of knowledge that could be gained about the existence and use of an online educational support system. The means by which these different paradigms were identified, employed and analysed was to take a series of metaphor-informed perspectives on EEMeC and to perform analyses based on each in turn. These were combined to create an evaluation profile of EEMeC as well as an exploration of metaphor as a basis for multimodal evaluation and a review of virtual learning environments as a whole.

The intended audience for this research includes those in the immediate EEMeC user community and communities like it who are interested in the use of VLEs in medical education, those who develop, support and manage VLEs both in medicine and in general, those who have research interests in the application and evaluation of learning technologies and those who have an interest in the nature and evaluation of contemporary education environments and organisations. It is hoped that different readers will recognise different aspects of their own experience in the work presented here whilst at the same time gaining a better understanding of what can actually happen as a result of introducing a VLE to a specific educational context.

This thesis is organised into twelve chapters. Chapter two reviews the form and use of virtual learning environments in general. Chapter three introduces the use of metaphors to inform different approaches to evaluation of VLEs. Chapters four to ten describe seven metaphor-informed evaluation perspectives on VLEs and EEMeC in particular. Chapter eleven draws the individual evaluations together and attempts to synthesise them into a single evaluation. Chapter twelve presents a discussion of the work undertaken and provides conclusions and indications for future work. A wide range of research findings and supporting evidence are provided in the appendices.

Chapter 2: Virtual Learning Environments

Although there is already much in the literature concerning VLEs, it has tended to concentrate on selection advice (Stiles, 2001; JISC and UCISA, 2003), reporting particular phenomenology of use (Richardson and Turner, 2000; Ellaway, Dewhurst et al., 2001b), general patterns of use (Jenkins, Browne et al., 2001; Browne and Jenkins, 2003), or developing particular theories or methodologies (Britain and Liber, 1999; Jochems, van Merriënboer et al., 2003). This chapter will provide a review of VLEs as an introduction to the subject of this thesis.

2.1: The Teaching and Learning Environment

VLEs are subsets of teaching and learning environments as a whole:

> *"the term environment has been used in higher education to cover different levels of description. At the institutional level, it describes policy, administration, regulations, buildings and social facilities, while at departmental or school level there is another set of administrative and organisational policies and arrangements, as well as collaborative decisions about how course content is selected and organised. The choice of course content in professional areas is, however, also influenced externally by validating bodies, and by the academic community within the discipline" (Entwistle, 2003, p4)*

Entwistle also suggests 'habitat', 'ecological niche' and 'umwelt' (the habitat as experienced by its occupant) as alternative metaphors for regarding the learning environment. Other models include Snyder's 'hidden curriculum' (Snyder, 1971), which looks at the institutional, departmental, administrative, teaching and student dimensions of the environment (which he calls the system), and observes the difference between the intended and hidden teaching and learning messages and activities within the system.

Scott opts for 'context' as a preferred metaphor for the environment and divides this into knowledge, power, teaching and learning, and structural context metaphors (Scott, 2001, pp37-40). Koper on the other hand has defined the learning environment from three different perspectives (object and context-based, social systems-based and goal-based) (Koper, 2000).

Teaching and learning environments will have many different participant roles, processes and systems:

- Students will be recruited, undergo their studies, complete coursework, communicate with staff and each other, take exams and hopefully complete their studies. They will also use various resources, participate in pastoral and social activities.

- Teachers will design, deliver and assess their courses, communicate with students and colleagues, undertake administrative duties, probably pursue research and engage with their professional and academic communities via journals and conferences.
- Administrators and clerical staff will manage business processes, such as logistical and financial support, human resources and record keeping.
- Support staff will look after facilities and services, such as libraries, computing facilities, classrooms and laboratories.
- Managers will set policy and strategy, organise the structure of the institution, validate and audit the activities of those in the institution, and will engage with funding and regulatory bodies

Each of these has its own professional identities, vocabularies and other specific ways of working. An important aspect of any learning environment is how all of its participant groups can work together to identify and achieve common aims and objectives. These issues have been discussed at length (Alexander, Broadhurst et al., 2003) and are well modelled in terms of Lave and Wenger's theories of interconnecting communities of practice (Lave and Wenger, 1991; Wenger, 1998).

2.2: Virtual Learning Environments

Virtual learning environments (VLEs) are the main focus of this thesis and will be discussed, defined and redefined throughout this work. However, to introduce the topic the following is a useful introduction :

> *"A virtual learning environment (or VLE) is an integrated set of online tools, databases and managed resources that exist as a coherent system, functioning collectively in support of education. VLEs are increasingly common in all areas of higher education, and in medical education in particular. This widespread use of VLEs is a relatively recent phenomenon; driven by the increasing ubiquity of computer-based activities in education, the ever-growing pressures for increasing the quantity and quality of educational efficiency and student support, and the technical opportunities provided by increasingly mature web technologies.*
>
> *How a VLE is used to support education is of course down to the local needs and creativity of the academic and support staff who develop and utilise the features, add the information and content, to develop a truly supportive online learning environment. Irrespective of which VLE system is being used, the goal is to provide students and staff with a range of online services and resources which will enhance the quality of the student learning experience and improve the effectiveness and efficiency of teaching.*
>
> *In a traditional learning environment students normally interact with and use learning ant teaching resources such as libraries, teaching rooms, study guides, lectures, tutorials, labs, reading lists etc. They will also use administrative and logistical systems such as registry, assessment, timetabling, clinical placements. And they will receive pastoral support, participate in evaluation and will most likely engage with many of the social aspects of university life.*
>
> *The virtual learning environment will often be developed so as to provide many, of the characteristics of a traditional learning environment. The balance between the online and the face-to-face is the essence of the 'blend' and is an inherently situated and locally negotiated equilibrium.*

A VLE may for instance provide learning and teaching resources such as searchable study guides and lecture materials, CAL materials, (streamed) video, discussion boards (both for general communication and for mediating online teaching and learning), and assessment. It may also provide administrative and logistical systems such as student records, student recruitment (even maybe online registration and payment of fees), assessment feedback and results, interactive and personalised scheduling and timetabling, and allocation and grouping support (for instance for arranging clinical placements or course options and electives)."
(Dewhurst and Ellaway, 2005)

2.2.1 Terminology

A useful starting point is to ask whether virtual learning environments are in fact simply a compound synthesis of the virtual, the pedagogical and the environmental. 'Learning environment' is however an established compound term in its own right so that 'virtual' can be seen as qualifying a particular form of learning environment. It is worth noting that the use of the term 'VLE' is mainly limited to the United Kingdom and the Commonwealth. In the rest of the world the term is usually 'learning management system' (LMS), and there are many other terms used interchangeably for what are essentially very similar systems. None of these have exclusive definitions or specific uses and as such they can be, and indeed are, used interchangeably with each other. Certainly there are significant differences between the systems that share the same name and there are significant similarities between those that are given different names.

2.2.2: Towards a Typology

Learning is, by and large, not the primary focus of VLEs; in general they are oriented towards a broad spectrum of teaching and support functions, only some of which are specifically concerned with learning. For instance the maintenance of class lists, the provision of course information and scheduling of events and deadlines, although often defining parameters of a specific learning environment, are not directly educationally oriented. It is when the system becomes the primary medium through which the learner is expected to learn, for instance in simulations, problem solving or project work, that they could more reasonably be called learning environments.

Furthermore these systems are not 'virtual' in the word's ephemeral or unreal sense (Shields, 2003). When deployed, they are inevitably a real, and even essential, medium for the students' and tutors' work. The only common term used in naming these systems that has any veracity is that of 'system'. Despite the looseness of definition, the term 'VLE' has suffused both the literature and the language of academic practice and as such it has become an increasingly futile task to gainsay this trend. Rather like a product name that has become genericised like 'hoover' or 'biro', 'VLE' now has such momentum of use that, despite the variety of entities it is used to describe, for the rest of this thesis the term 'VLE' will be used.

Functional scope is not the only way of creating a typology of VLEs. There are a number of dimensions that can usefully distinguish between systems and have been found to be a common currency for describing VLEs, including off-the-shelf vs purpose-built, commercial vs open source and generic vs context-specific.

A VLE may be purpose-built or it may be acquired as a finished product from elsewhere. Initially almost all VLEs were purpose-built as no off-the-shelf systems had yet been developed. A few companies reconfigured existing business productivity tools as VLEs (notably the Lotus Notes product). Many, if not most, of the first generation of purpose-built VLEs fell by the wayside as costs, immature technologies and a lack of interoperability and sustainability options rendered them unviable and obsolete. At the same time a number of commercial VLE vendors appeared, foremost among them WebCT and Blackboard, releasing products to address many of the scalability and sustainability issues of the first generation systems. A number of purpose-built systems still exist and some are still being developed but by and large institutions have opted for off-the-shelf solutions. Some of the advantages and disadvantages of each are laid out in table 2.1.

	Off-the-shelf Systems	*Purpose-built Systems*
Advantages	No development costs Dependent on skills of supplier Common system with other institutions Updates and patches	Retains and builds local knowledge Only builds what is needed Easier to adapt and change Complete freedom of approach
Disadvantages	Abdicates knowledge to supplier Harder to adapt and change Approach constrained by system	Initial development costs Dependent on local skills Different from other systems Subsequent development costs

Table 2.1: comparison between off-the-shelf and purpose-built VLEs

	Commercial Systems	*Open Source Systems*
Advantages	Dependency of established vendor Contractual obligations clearly set out Known costs Technical support	No purchase or licensing costs Some if not most development already completed Backing of open source community
Disadvantages	High initial purchase cost plus potential licensing costs Dependency on vendor in volatile market Costs and other contractual terms may change after committing to a system Product rather than service mentality	Development work still required Tools may have to be shared with developer community Architecture dependent on developer community Service costs for supporting open source activity

Table 2.2: comparison between commercial and open source VLEs

An ‘off-the-shelf’ VLE may be bought from, or made available to sell to, another organisation, it may be freely available, or it may be built upon freely available components or architectures. Of course a purpose-built system may be neither of these but increasingly issues of interoperability are obliging at least this level of open-source capacity. Although developments such as MIT's Open Knowledge Initiative are creating common protocols for open source systems, at the time of writing full open-source systems are relatively rare. Commercial systems on the other hand are the dominant form of VLE in use today with market leaders such as WebCT and Blackboard providing systems for many if not most institutions in the higher education sector in Europe, North America and beyond. Some of the advantages and disadvantages of each are laid out in table 2.2. A VLE may be designed or built for a specific context of use or a range of different contexts of use. Some of the advantages and disadvantages of each are laid out in table 2.3.

	Generic Systems	*Context-specific Systems*
Advantages	Should suit most if not all situations 'One size fits all' Common approach and methodology used across different settings	Good fit to the immediate context of use Supports diversity and specificity
Disadvantages	Does not fit to any specific context Mitigates against diversity and specificity	Cannot easily be used in dissimilar contexts Need to support many different approaches and methods

Table 2.3: comparison between generic and context-specific VLEs

These three continua are not unrelated. In particular, off-the-shelf systems are by their very nature generic while purpose-built systems are likely to be serving particular contexts. Open-source approaches are as likely to be found in purpose-built as off-the-shelf systems. In order that these various dimensions can be used together and real systems mapped against them the three continua can be assembled to create a cubic mapping space as shown in figure 2.1. This approach has proved useful in previous work looking at complex dimensional mapping (Ellaway, Mogey et al., 2001; Ellaway, Mogey et al., 2002).

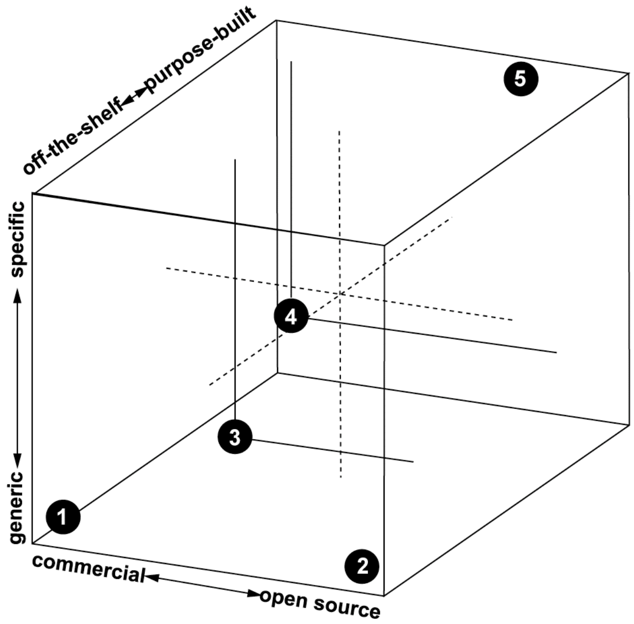

Figure 2.1: a VLE continuum cube showing five systems mapped in the volume: 1) a large commercial system such as WebCT, 2) a general open source system such as Moodle, 3) a local system repurposed for general use such as COSE, 4) a purpose-built commercial system such as that developed for the UK e-University and 5) a purpose-built system for a local context such as EEMeC

2.2.3: Proximality and Distality, Activity and Passivity

Proximal components are those aspects that are essential to but not part of the VLE. These include browsers and other client software, operating systems, plug-ins and the networks they all use. The distal components are those third party systems that a VLE may interoperate with. These include common authentication services, library, registry and finance systems and extra-institutional systems such as repositories of learning materials, bibliographic databases or other Internet-based systems and services. The intra-institutional components are often considered as a whole to comprise a managed learning environment (MLE).

Active components are those that have a reciprocal relationship with the subscribing system. These include any external system that requires common authentication or processes search and retrieval requests. Active components therefore engage in dialogue with the VLE and indeed are dependent on this dialogue. Passive components on the other hand are those that function independently of the VLE (or any other system). Passive components therefore pass services and information to any subscribing system with no dialogue between them. Examples include Internet sites (rather than applications) and portal channels.

Although these components sit outside the immediate bounds of a VLE, they are still essential parts of the user experience and they may provide essential information and services to the VLE application. For instance, the provision of a class list from the registry or an electronic reserve from the library might be crucial to the functioning of the system.

2.3: The Form of VLEs

2.3.1 System architecture

Although a number of early VLEs had their own specialist client applications or only worked on local area networks, the majority of contemporary VLEs are web-based applications that generally conform to an n-tier system architecture, where any number of web-based clients connect to a web server layer. These connections may in turn run server-side script components, i.e. code that is designed to run on the server in an application layer along with any parameters relevant to the script. The application may in turn call other server components, most commonly a database or databases (figure 2.2).

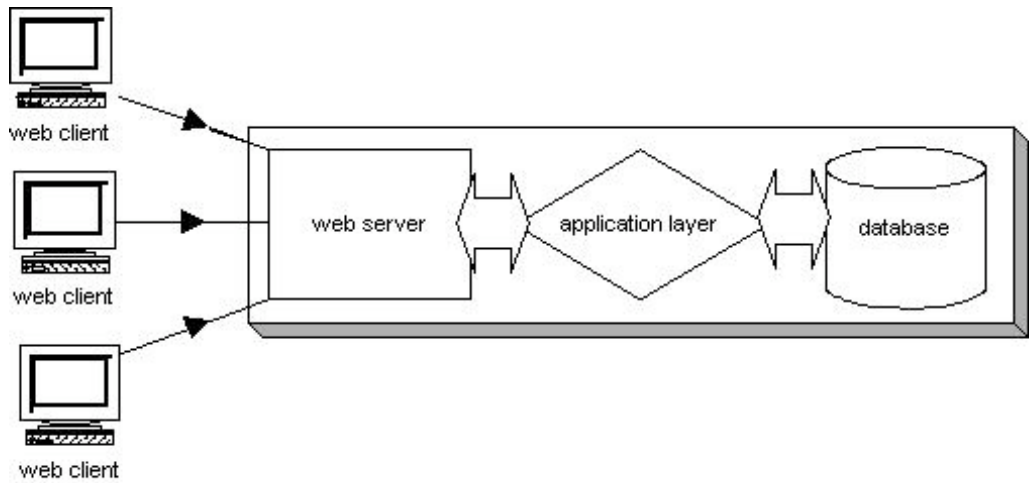

Figure 2.2: basic n-tier architecture model for a VLE

More basic systems conform to a 3-tier architecture where there is no separate application layer between the web and database layers (Beynon-Davies, 1996, p379). This is rare in terms of VLEs as the focus on tools, rendering and information management almost always calls for a well-developed application layer. A VLE may also connect to external applications, such as authentication mechanisms, middleware components that allow heterogeneous systems to interact (such as VLEs and library systems), and student records databases or resource repositories (figure 2.3). There are many VLE systems that show some degree of variation from this general model. For instance WebCT creates a separate application layer and database for each course instance. Other systems, which may start to look more like an MLE, may have a lot of services and functionality running across a number of federated applications.

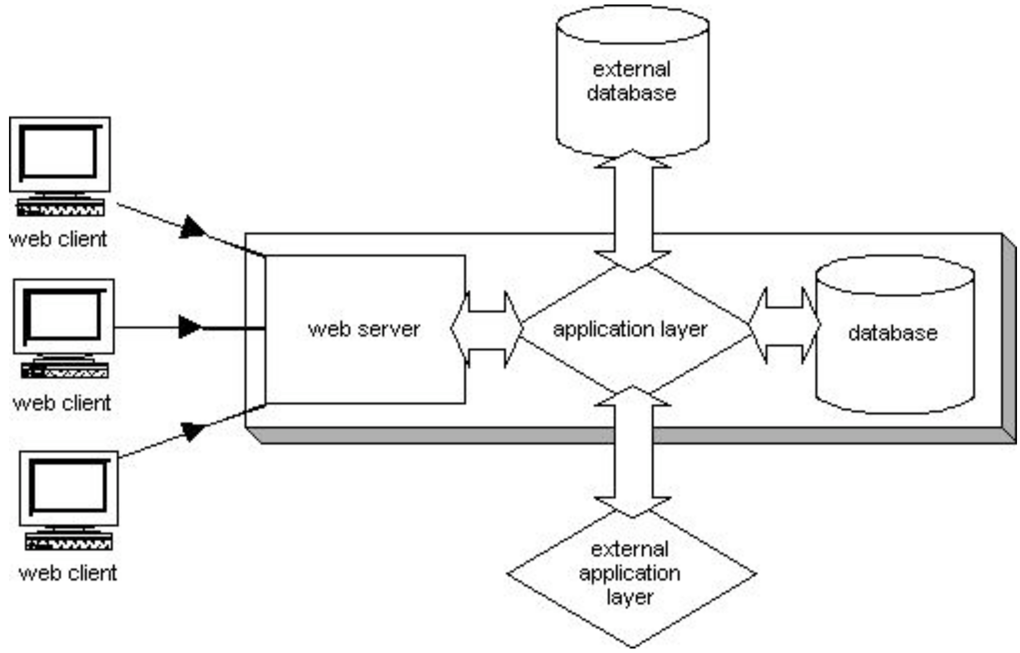

Figure 2.3: extended n-tier architecture for a VLE

2.3.1.1 Client level

The client level consists of all of the web clients connecting to the server. These will be on behalf of individual users who will be using standard desktop web clients or 'browsers' such as Internet Explorer or Mozilla.

Although mostly server-side, some application functions can be run client-side, for instance a web server can set user-specific data 'cookies' on a client browser and scripting technologies such as JavaScript can provide form validation. Web clients will connect using the standard web protocol (HTTP) although file transfer (FTP) and email may also be used. From the user perspective the browser acts as a local terminal of the VLE, and is the medium through which most transactions and interactions take place.

The client layer is generic in that web browsers can be used for any web site or service. Some VLEs have used a specific downloadable client but this is relatively rare. All major contemporary VLEs are web-based although some retain some specific client authoring tools.

2.3.1.2 Web server level

The web server is the server layer that handles incoming HTTP requests and outgoing HTTP returns. The two most common systems are Apache (usually found on the UNIX family of servers) and IIS (the default for the Windows family of servers).

The web server level also resolves host headers (allowing multiple web sites and applications to be hosted on the same machine), manages site security and access (including certification and encryption) and specific functions such as how the application layer is called, limits on IP and user access and mappings to virtual directories. The web server level will by default keep its own log files and can integrate with local user and security policies on the server. The web server level can be quite generic as it may be able to serve non-VLE functions and is often a standard server component.

2.3.1.3 Application level

The application layer is that at which the specific application's programmability resides. Most commonly this will consist of numbers of scripts, either pre-compiled (CGI, Perl, C++, Java) or running in real-time compilation mode such as Active Server Pages (ASP), Zope/Python, Java Server Pages (JSP), PHP or Cold Fusion (CFM).

The application level is also likely to be generic in terms of supporting one or other programming or scripting language. The programs and scripts will be specific to the VLE application however and these, along with the database, will be part of the core of the VLE. These scripts will process requests, transmit data to and from the database, process and render this information and make and process interactions with other applications such as library systems and learning object repositories.

2.3.1.4 Database level

The most common form of databases, known as 'relational databases', consist of a number of tables of data, which have a number of fields within them. If a table is considered as a grid then the fields are the column headings and a record in that table is a row in the grid. A table would be expected to have many records, each corresponding to entries in the respective table fields. Relational databases can in theory be made more efficient through the process of normalisation – that is the abstraction of repeating data into sub-tables and table-table joins. Most relational databases can be queried and manipulated using a common scripting language called 'structured query language' or SQL.

A database's schema is a description of the tables, the fields within the tables, and the way the tables and fields are linked to each other, and it describes other objects such as views and stored procedures. It is the database schema that makes up the second part of the VLE core. Data is the essential lifeblood of a VLE system. At the core of every VLE is a database that stores and manages data about users, resources, events and educational processes such as teaching and assessment. This data is integrated with other data and with system resources in the pages and tools in the system's application layer.

This is a key issue when considering the use or development of VLE systems. The quality of service a system can provide is fundamentally tied to the quality of the data it holds. If data is absent then processes and services that are dependent on it cannot take place and if data is incorrect then dependent processes will also be incorrect. For instance, failing students should not be logged as having passed assessments, cancelled events should not be logged as having taken place and users should only be given permission to see the information and resources they are entitled to see. The primacy of data quality in a VLE cannot be overstated.

Some of the data in the system is generated by users as a result of the system being used or is generated by the system itself, but much will need to be uploaded into the system from external sources. The degree to which this is the case is an indicator of a VLE's dependence on external systems and practices and therefore is dependent on the quality and efficiency of these systems and practices. The degree of automation of populating a VLE with external data will also be an indicator of efficiency. For instance, an otherwise powerful VLE system may depend on the manual keying-in of data or the formatting and reformatting of data using word processors and low-level spreadsheets before it can be uploaded. On the other hand data validation and verification will also need to take place to guarantee its existence and accuracy. Some of this may be automated by using common unique identifiers or 'keys' while some may always need to be checked manually.

2.3.2: System Heuristics

VLEs, like any other system, are designed around a basic heuristic model of how the learning environment should be organised. Some of the more common heuristical models found in VLEs include:

- Modular: the principle unit of activity is a module, covering a discrete topic for a discrete number of students and staff over a discrete period of time. In this situation there is a separate VLE instance or container set up for each module in a modular programme. An institution may therefore have many hundreds of modules, each with a discrete VLE instance. The large commercial systems largely fall into this category, in particular WebCT. This is equivalent to the 'online course environment' defined earlier. Problems can occur when a number of modules need to be grouped together so they can work as a whole as well as discretely.
- Modular Institutional: this is essentially the same as the previous system but with the addition of institutional tools such as portal functionality, student records and connection to library and other service systems, that span all of the module instances or containers. Examples include Blackboard and WebCT.
- Programme-wide: this is where the primary heuristic is still based on the organisational disposition of an educational setting but differs from modular systems by focussing on a complete programme of study along with its constituent modules, courses and other activities. Although there have been some attempts to support this kind of heuristic by modular systems, there is at the time of writing no commercial system that meets this description; all such systems have been purpose-built. This is equivalent to the 'online programme environment' or OPE described in an earlier section.
- Resource usage: this is where the primary heuristic is not based on the organisation of the education setting but is about connecting learners and teachers to the resources they need. Now commonly addressing a 'learning object' model, these systems combine aspects of a

learning object repository and educational frameworks for presenting these objects. An example of such a system is the Giunti LearnXact platform adopted by the International Virtual Medical School (IVIMEDS).

- Single function systems: while the previous types of system heuristic support a range of primary functions, there are VLEs which have only one primary function, which is therefore also its primary heuristic. These include course administration such as the VALE system at the University of Glasgow or communication such as the FirstClass system used by the Open University.

Not all educational settings are the same and a VLE's heuristics will not suit all contexts of use. For instance a programme-focused context would be sorely limited by using a modular system. Simple systems may not support the multiple user identities or the complex, integrated educational processes involved in some educational contexts, while others may be overly complex for a simple situation. Systems that provide a predefined set of tools and practices may offer little scope to shape the system to specific course needs.

A VLE should therefore be matched to the educational context in which it will be used. If this is not done then either changes in existing courses and practice would be needed to match those of the adopted system, effectively:

> *''acquiescing in the pre-emptive choices and knowledges of the supplier'' (Scarborough and Corbett, 1992, p22)*

or only those aspects of the system that can be used will be used leading to inefficiency and gaps in coverage.

2.3.3: System Components

VLEs integrate a number of different functions and services into one system. Some components will vary between systems while others will be common to all. These components can include:

- Scheduling: the provision of timetables or calendars of events, the organisation of staff and student time, the organisation of rooms, meetings and other events, and the milestones and stages of a course's cycle.
- Communication: this includes both one-way and two-way communication between staff and students including email, discussion boards (asynchronous) and chat rooms (synchronous).
- Course Content: this would cover both the support of actual working processes of the course such as simulations, problem-based learning and group or project work, as well as the storage, authoring and presentation of more static course content. This would also include the provision of banks of images and questions and learning object repositories.
- Assessment: this includes both the support of formative and summative assessment and the administration and logistics of assessment processes.

- Personalisation: the system may provide opportunities for individual users to customise and personalise it to their own interests and activities. This would include personal pages, the ability to annotate content, the provision of personal timetables and the ability to set up closed groups for communication and sharing resources.
- Administration: this includes the creation and maintenance of class lists, the tracking of staff and student time, the use of resources and the completion of audit and other record keeping activities.
- Regulations: this includes the provision and maintenance of the rules, codes of practice and documentation relevant to the management of the course.
- Presentation: the provision of the presentation and teaching materials (as opposed to learning materials) such as lecture and tutorial resources.
- Portfolio: the submission and storage of portfolio items such as coursework, logbooks and personal reflections.
- Curriculum: the provision of course and pedagogical frameworks such as curriculum guides and maps, learning objectives and outcomes and the options and opportunities students may pursue.
- Portal Services: this covers the provision of third party functionality and content through the VLE. Examples would include searching external catalogues and repositories, streaming video and linking to external materials.
- Security: this includes the provision of authentication for users, security of content and the maintenance of privacy over sections and content within the system.
- Multiple Roles: this allows different users to have different rights to features and functions within the system. A tutor may be able to set up tasks and activities and edit materials whereas a student will not, a student on the other hand may have areas private to them and administrators may be able to add or extract course information without participating in the teaching and learning process. Some systems may only have a restricted range of user types while other may support any number of roles.

2.4: Phenomenology of VLEs

2.4.1: History

Although relatively primitive VLE-like systems have been in limited use since the 1980s (for instance using email and IRC protocols) the VLE, as we now understand it, only became a viable prospect with the move to mass use of the Internet and the development of programming and database technologies that could be linked to it. The earliest VLE systems were primarily based around shared communication tools and course content and consisted mostly of purpose-built systems. At this ‘innovator’ stage most users were keen individuals rather than whole departments or organisations. By the late 1990s commercial VLEs emerged and some institutions started to move to cross-institutional use of VLEs, both off-the-shelf and purpose-built systems (Follows, 1999; Quentin-Baxter, Hammond et al., 1999; Milligan, 1999). The first few years of the new century saw many more institutions adopting VLEs, national support schemes being set up and commercial systems becoming the norm across the tertiary sector (Ingraham, Watson et al., 2002; Browne and Jenkins, 2003). However, despite the fact that systems were available in an institution, many parts of a typical organisation remain untouched by their presence (Browne and Jenkins, 2003, p6).

2.4.2: Current Patterns of Use

At the time of writing, VLEs have become the norm in most tertiary institutions with a discrete but growing number of courses using them within these organisations. A recent report from the UK’s Universities and Colleges Information Systems Association (UCISA) indicated that in 2001 18.7% of higher education institutions (HEIs) had no VLE, by 2003 this had fallen to 13.7% (Browne and Jenkins, 2003, p1). Those institutions that were going to use VLEs were now mostly using them and a number of institutions were already on their second or third systems (including the University of Edinburgh).

As to which systems are being used, the UCISA report also indicated that Blackboard had the largest market share with 43.2% of the respondents using it, WebCT a diminishing but still substantial share with 34.1% of users, and the use of purpose-built systems growing from 11.3% in 2001 to 22.7% in 2003. The UCISA figures for staff and student usage were given as absolute numbers rather than percentages and as such cannot be meaningfully compared. What this report does seem to indicate however is that relatively few students were using VLEs across an institution as a whole with just a few pockets of active use where enthusiasts or other local conditions have been favourable to adoption.

2.4.3: One System, Two Systems, Many Systems

Along with a move to mass use of VLEs, many institutions that have previously had multiple systems are now moving to centralise on a single system, abandoning a plurality of systems for the simplicity of a single system (for instance at the universities of Birmingham, Cardiff and Nottingham). Other institutions that have multiple systems may have discontinued the less viable systems while still maintaining a small number of VLEs (for instance at the universities of Edinburgh, Aberdeen and Newcastle) or may allow any number of VLEs to be used (as in many North American universities such as Johns Hopkins).

The reasons given for centralising on a single system are usually based on principles of simplification and sustainability, in particular where a central service is supporting a VLE or where a common approach to teaching and learning support is required across an institution. The increasing use of portals (that channel many services into a single system) also provides a trope towards a single system approach. It is important to observe that the main drivers for centralisation usually emanate from business or IT management cultures rather than academics or students and that such moves have been criticised for reducing the options and diversity of educational practice (Ellaway, Dewhurst et al., 2001a). Maintaining a range of systems can support a wider range of contexts of use thereby maintaining diversity. However, as the central IT services are, by and large, tasked with installing and maintaining VLEs, and senior management make the decisions on the associated costs and strategic implications, it is often their perspective that predominates.

2.4.4: Distance Learning and Blended Learning

There are two distinct modes of using VLEs: 'distance' learning where students have no face-to-face relationship with their tutors and peers and 'blended' learning where students do have face-to-face contact with tutors and peers. In distance mode the VLE will provide the principal medium for their studies while in blended mode the VLE is one medium among many. Although there are an ever-growing number of circumstances where VLEs are used for distance learning, the dominant model in the UK is still an on-campus blend, particularly in support of undergraduate education. In fact all use of VLEs is blended; even when at a distance the learner will almost certainly make use of books, study guides and other non-VLE and offline sources.

Clark has defined a number of dimensions for blended learning: 'component' where the elements are separate from each other and the learner is expected to use them in series; 'integrated' where the elements are combined into one system; 'collaborative' where communication and tutoring is added; and 'expansive' where workplace learning and other extended activities are included (Clark, 2003). In an academic setting a VLE would equate to a collaborative level of blended learning support whereas when used in support of vocational academic practice (such as medical education) the expansive mode is more likely to be the level of blended learning supported by the VLE.

2.4.5: Closed and Open Systems

If a system is closed, i.e. it is an off-the-shelf system without options to extend its back-end functionality, then only the vendor or supplier can make such changes and extensions as are needed, and it is likely that their preparedness or ability to do so will limited by commercial factors. Some off-the-shelf systems may have application programming interfaces (APIs) to allow a degree of customisation although these may be a more expensive version than the uncustomisable standard version. Both WebCT (Vista) and Blackboard (Building Blocks) take this approach. Even if customisation is technically possible it may still be against the licensing agreement between the supplier and the client institution. On the other hand, if the system has an open architecture then customisation should be straightforward. The use of these 'open source' VLEs has increased significantly in the last few years, principally because they combine the benefits of a pre-existing system with the adaptive affordances of freely available code. Examples of open source systems include Moodle and Boddington.

2.4.6: Monolithic and Federated MLE Architectures – Interoperability

Some systems may provide most if not all of an institution's services, functioning as a single MLE, while others will use one or more VLEs in the context of other specialist systems. In the latter circumstances, the component systems will need to be able to work together to act as a federated MLE. In order to do so, these systems will need to be able to interoperate with each other. Initially, interoperability was based on specific or proprietary protocols, but more recently bodies such as the IMS, IEEE and W3C have developed common and open interoperability protocols for components within an MLE to interoperate with each other.

2.4.7: Product, Service or Process

There are three distinct ways of modelling VLE provision as a product, service or process. In a 'product' mode a VLE is a commodity that is bought and owned (or licensed) by an organisation, plugged in and run. In a 'service' mode a VLE is an ongoing set of activities and responsibilities to a systems' users while in a 'process' mode a VLE is developed and integrated with appropriate processes and activities. Vendors, third party developers and funding councils tend to take a product perspective, managers and IT staff tend to take a service perspective while teachers and students tend to take a process perspective.

2.5: VLEs: Personal, Institutional, National and International Contexts

Different users and groups have different perspectives on VLEs, ranging from the highly proximal to the highly distal.

2.5.1: The Student's Perspective

Undergraduate students generally take the circumstances they encounter when they enter tertiary education as the norm. Unless it is particularly dysfunctional, the VLE they use will therefore be taken as given and will not usually be questioned. There is a fairly common expectation for more and better support, both educational and pastoral, and as such, if a VLE is perceived as being able to provide that support then students have tended to be proactive enthusiasts for using such systems. The corollary of this is that when things do not function as they might that they are often also the harshest critics.

Students do have concerns with some of the effects of moving to a VLE-supported environment, for instance the costs of printing notes and resources are being moved to the student as materials are only supplied online. There are also issues over access to computers, particularly in certain settings (workplace-based learning environments for instance), and concerns that VLEs mark the 'dumbing down' of education by reducing teacher contact time.

2.5.2: The Teacher's Perspective

Teachers will have spent much longer than their students in higher education and are responsible for providing them with learning opportunities. VLEs have yet to become perceived by teachers as a truly normative component of the teaching and learning environment. Despite this one of the reasons that VLEs have been widely adopted is as a response to increasing student numbers and a reduction in funding; implicitly at least there is an expectation that a VLE will make the teacher's work easier and more efficient. Using a VLE may require teachers to rethink the way they teach and how they work with their students. It may also require different and potentially new skills, and will need to be carried out in a different support environment. As such a VLE may not provide initial benefits and may indeed make a teacher's life harder, paradoxically at the same time as it provides a better student learning experience.

It has been observed the first and second generation of VLEs concentrated on establishing a viable functioning system rather than supporting innovation and that accordingly there is little to support the teacher in innovating or developing any more than they already do in face-to-face settings (Britain and Liber, 2004).

2.5.3: The Institutional Perspective

Many institutions see a VLE as one of their many essential business systems, akin to the library, registry and communications systems they already own. Many of the same criteria of single system efficiency and central control may be exercised over the VLE and the same causal expectations made of its ability to support learning. As VLEs may incur significant up-front and recurrent costs, it may only be viable at a cross-institutional level. Certainly the advice and guidelines available for prospectively evaluating and procuring VLEs are almost exclusively aimed at institutional managers and IT professionals (JISC, 2001).

It has been observed that institutions do not often know what they want and therefore what system they should have or how it should be configured (Cornford and Pollock, 2003). In these circumstances the usual practice is to accept the system defaults and reconfigure the organisation and its activities around what is presented to them.

2.5.4: National and International Perspectives

A mix of competition and collaboration mark the relationships between institutions, and in this respect VLE use is no different. National bodies such as funding councils and technology advisory bodies usually determine which is the dominant factor at any given time. In the UK, at the time of writing, a decade of inter-institutional competition in learning technologies has given way to one of collaboration, largely driven by funding opportunities from the Joint Information Systems Committee (JISC) and the regional higher educational funding councils.

The use of VLEs is now widespread in university education across much of the developed world and is becoming increasingly common elsewhere. Patterns of use tend to be organised along national lines as they represent the way education is organised and funded. Increasingly trans-national organisations are using VLEs for internationally based teaching and learning. Examples include the International Virtual Medical School (IVIMEDS), and the Health Academy run by the World Health Organisation.

2.5.5: The Commercial Perspective

The use of VLEs is becoming widespread in business, mostly in support of training rather than education, and mostly under the guise of learning management systems. Examples include the University for Industry in the UK and the military and aerospace industries in the United States. So influential are the latter that a number of e-Learning specifications have been developed primarily for use within these sectors (in particular ADL/SCORM). A major difference in the work-based sector is the emphasis on training rather than education and the way it informs the quality of the activities of the participants in their mainstream duties. In education learning and the resulting academic awards process are the mainstream activities.

2.6: Medical Education, VLEs and Online Learning Support

Contemporary medicine is a fundamentally technology-based phenomenon (Reiser, 1978). It should not be surprising therefore that there has been a substantial use of technology in medical education. Some of the forms this has taken include:

- Tutorials: these are discrete packages that take a student through a single topic, usually employing a stepwise and interactive approach.
- Reference materials: these are general reference materials without any particular heuristical intent, such as anatomy and histology atlases, pharmacopoeias and surgery manuals.
- Self-assessment: these are banks of formative questions, quizzes and tests to allow students to electively test and gauge their knowledge of a particular subject.
- Textbook enhancements: these are where a standard medical textbook has provided a CD-ROM or website that enhances and extends the materials in the book.
- Simulations: these include cases, clinical scenarios, surgical procedures or body regions modelled so the student can move through them and manipulate them in an exploratory fashion.

- Videos: these are usually passive media where a scenario, procedure or some other entity is presented for the student to observe and consider.
- Videoconferencing: this is where surgical procedures, examinations or case conferences are broadcast in real time to other settings. This is particularly useful where presence is a problem for instance in operating theatres.
- Primary evidence for evidence-based medicine: because medical education is fundamentally based on actual clinical practice, students are required to engage with primary research material in support of evidence-based medicine. This is to a great extent done online through bibliographic databases such as PubMed.
- Productivity tools: medical students will, like any other student, use standard productivity tools such as email, word processing, spreadsheet, database and presentation applications.
- Communication: there is a strong communication theme in medical education; communication with patients and with colleagues in multiprofessional teams. This is increasingly incorporating electronic communications media and its appropriate use in clinical settings.
- Medical Informatics: this includes many of the topics already mentioned here, but it also includes large-scale hospital and practice information systems, medical imaging and information flows in clinical settings. In this case, as Mcluhan has famously observed, 'the medium is the message'.

It is clear from these examples that the use of technology in support of medical education is both well established and pervasive. It is common for medical schools to have dedicated learning technology support officers when most other disciplines do not (for instance in all of the Scottish medical schools). Given the established background use of technology in medical education it is perhaps not surprising that VLEs have been used extensively throughout medical education.

In a survey of VLE use in undergraduate medical education in the UK in 2001, 17 of the 21 respondent institutions had implemented a VLE while all of the others were in the process of doing so. 15 were taking a purpose-built path, 5 an off-the-shelf one and 1 had not decided. The main reasons for use were "to facilitate learning at a distance, to manage curriculum change, and to handle increased student numbers" (Cook, 2001). An updated follow-up report has been commissioned but is unavailable at the time of writing.

Cook's survey had 21 responses from the then 27 medical schools (there are now 32 in the UK) so the data should be seen as illustrative rather than absolute; note that the UCISA survey had a similar response rate. Comparing these two surveys shows relative degree of adoption and the kinds of system used (figure 2.4).

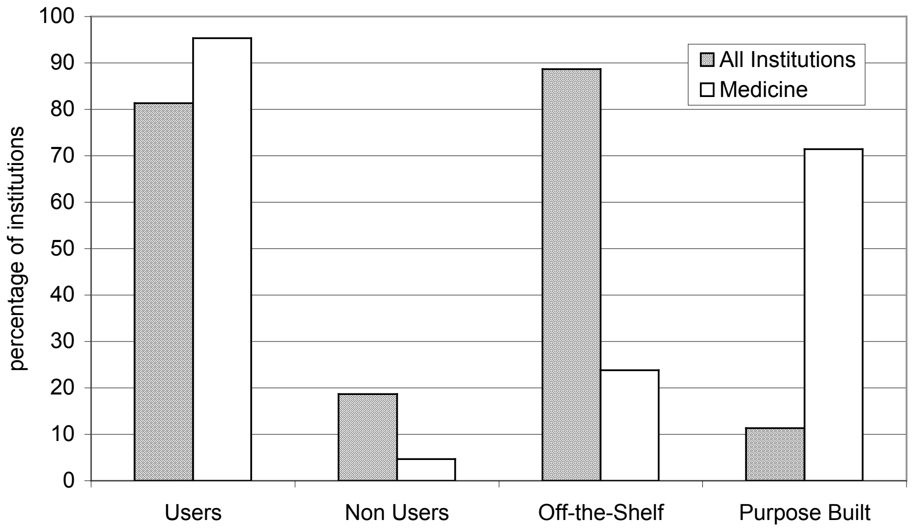

Figure 2.4: comparison between VLE use and type of system for all UK HEIs and UK medical schools in 2001. Source data: (Cook, 2001; Jenkins, Browne et al., 2001)

Although the comparison data is for 2001, only UCISA has newer figures (for 2003), so a longitudinal comparison is not currently available. As an illustration of some current patterns; in a survey across medical schools in Scotland in 2004 all five were using VLEs, only one of which was an off-the-shelf solution. In all of the other schools there were central off-the-shelf systems in place and there were varying degrees of pressure being exerted to abandon the medicine-specific VLEs in favour of the centrally provided solution. The strengths and weaknesses of using VLEs in medical education have been identified as follows (Dewhurst and Ellaway, 2004):

- The ability to interact with a course even when geographically or temporally distant from it
- The ability to support personalised learning experiences
- The ability to better manage the logistics of the learning process
- The ability to better manage the administration of the learning process
- The ability to support and extend the essence of a community of practice
- The ability to support audit and quality assurance and to create a course 'knowledge base'
- The ability to provide integration with other systems, either within an institution as part of an MLE or beyond the institution as gateways to repositories and collections of third-party resources

While the problems include:

- A VLE cannot and should not replace the intrinsically people-focused nature of medicine.
- Problems can occur when a VLE is over or under used. Finding the balance in the blend therefore is one of the challenges for those working in this area.
- VLEs can be expensive, both in terms of purchasing or development and in terms of maintenance and support.

- Managing the change from a traditional to a blended learning environment can be problematic.
- A VLE can make the course and its participants more exposed. Securing online environments is therefore a serious matter, particularly concerning the perils of hacker and virus attacks on computer systems. Legal aspects, such as data protection and freedom of information, are also a major concern.
- Using a VLE will lead to a tighter coupling between educational processes. The failure of a VLE may have major ramifications, possibly catastrophic, and affect a wider range of course subsystems than would previously have been the case.

2.7: Defining a VLE domain space

VLEs, irrespective of their specific form and function have a common aetiology in that they are a synthesis of technological, educational and systems practices. Individually and in pairs these domains are well established with distinct practices, epistemology, and semantic structures. Firstly, VLEs are computer-based applications with hardware and software components, accessed through networks and depending on information and communication technologies and their associated affordances. Secondly, VLEs are educational in that they are specifically designed to support educational processes such as teaching and learning. And thirdly VLEs are systems-based in that they consist of integrated components and tools that facilitate integrated activities and processes (see figure 2.5).

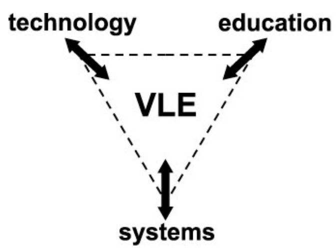

Figure 2.5: VLEs synthesize three domains; technology, education and systems.

This three-way dynamic join is true of a VLE in the abstract, such as a VLE awaiting installation and use or a VLE devised and built in isolation from an intended context of use. This thesis differentiates between two types of VLE phenomena:

- VLE-in-abstract: systems considered, developed or deployed without regard to any specific learning context. This is the form generic commercial systems take, where they are intended to support a range of different contexts and can exist as a distinct artifact or product.
- VLE-in-use: systems considered, developed or deployed with regard to a specific learning context. This is the form any VLE takes in use including those VLEs that are developed as an

integrated process within a course context. This entity cannot be separated from the course context without reverting to the first abstract state.

Returning to the domain space proposed in figure 2.5, context can be added as a fourth domain, representing a VLE-in-use as a synthesis of these four domains (see figure 2.6).

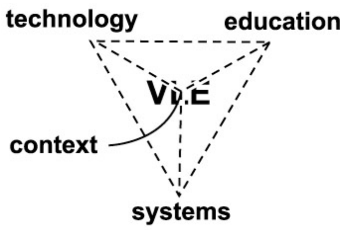

Figure 2.6: the VLE-in-use is further informed by its specific educational context.

Interestingly, this tetrahedral model is similar to one developed by Pacey describing technology practice and experience, which consists of social, political and technical base domains extended by personal experience (Pacey, 1999). In his model Pacey places personal dimension below the others as being often hidden relative to the others.

2.8: Summary

This chapter has reviewed the history, form, function and phenomenology of VLEs, both in general and in the context of medical education. A number of factors have been identified that shape and define the VLE and how it is used:

- A VLE may have the potential to be used in many different ways, but in practice that potentiality collapses to specific patterns of use. Constituent functions may or may not be used or they be used in ways for which they were not designed. Furthermore there can be cascading effects that as one affordance is realised then another may become potentialised. For instance, by using online discussion boards geographically distant individuals can interact and participate in group activities; by doing so further forms of collaborative activities become potentialised, and so on.
- A VLE-in-use will be informed by and indeed will become part of the local activity context. The educational, cultural, organisational, infrastructural and social dimensions of this local context will be the determining aspects of how a VLE is used and therefore how the VLE can have an impact within its context of use. Furthermore, those dimensions of use may tend to be interdependent and if so they should be viewed and assessed holistically.
- By encompassing a range of functions and roles, a VLE interacts with many differing aspects of the context of use. These aspects may be quite different and involve different individuals, roles

and value systems. For instance, students, administrators and technical staff may be expected to use, and therefore perceive and value a VLE in very different ways.

- In its most basic form, a VLE is a software system with which users interact. However, these interactions take place and are fundamentally part of the socio-cultural dynamics of the VLE's local operating environment, and are therefore informed in turn by that environment's broader socio-cultural contexts. Even before a VLE is deployed, its characteristics are shaped by the social meaning inherent in its design and its expected operating parameters.
- The reasons for using a VLE are many, they will most likely differ between different user groups, and they may possibly be contradictory. The use of a VLE may be intended to facilitate more or different forms of activity or outputs. For instance it may be intended to support increased student numbers or to stimulate more discussion between students. The use of a VLE may be intended to facilitate qualitatively improved activities or outputs. For instance it may be intended to provide a richer selection of learning opportunities or improve communications between members of a dispersed learning community. It is most likely of course that a VLE will be intended to facilitate both quantitative and qualitative benefits.
- A VLE may be used for proximal benefits to its user community or it may be used to achieve more distally oriented outcomes. An institution may choose to deploy a VLE in order to provide a common infrastructure to all courses, irrespective of whether there is a proximal need for such infrastructure. The distal influence of politic imperatives, funding bodies and the tensions of heterogeneity can significantly influence what is done locally and how it is valued at a distance. Thus, distal bodies such as funding councils and institutional managers and service providers may influence or otherwise counter or compromise the local dynamics of VLE design and use.
- VLEs are intrinsically coupled entities, that is their constituent parts and subsystems are coupled to each other to some extent so that a state change in one part will cause state changes in other parts. Changing the way information flows between subsystems could radically affect whether subsystems function or whether their functions continue to be meaningful. Increasing degrees of coupling could mean that a catastrophic failure in one subsystem could cause a catastrophic failure in all subsystems and thus in the system as a whole. The coupled nature of systems is reflected in the way they are perceived by their users. Thus if one part of the system is seen to fail this can be perceived as a failure of the system as a whole. Systems failure is a field of study in its own right (Sauer, 1993). A VLE by tying student records, timetabling and communication into a tightly coupled system may create close synergies and economies of scale but may also risk a failure of one component subsystem leading to the failure of all subsystems.

A VLE problem space was defined as consisting of a synthesis of technology, education and systems. A fourth dimension of 'context' was added when a VLE was actually being used. This defined two forms of VLE: VLE-in-abstract and VLE-in-use. Having now described the nature of VLEs the next chapter will consider the use of metaphor as a medium for informing research and evaluation.

Chapter 3: Metaphor and Evaluation

3.1: Multiple Methods Evaluation

A fundamental question any researcher must face is whether they will focus on specific parts of a problem or whether they will tackle the problem as a whole. The evaluation of the use of technology in educational settings covers a particularly diverse range of activities and approaches (Draper, 1996; Oliver and Conole, 1998). As a result there is no single approach that is likely to be appropriate for evaluating VLEs. Indeed, the multifaceted and complex nature of VLEs and the ways they are used reinforces this problem. Regarding VLEs, some studies have focused on their educational benefits (Stiles, 2001; Konrad, 2003) whereas more holistic studies have tended to pursue phenomenological or theoretical positions (Britain and Liber, 1999; Barajas and Owen, 2000). The importance of context and the multi-factorial nature of complex learning technologies like VLEs is well summed up thus:

> *"across different settings, there may be significant variation in how radically the same technology serves to restructure the activity of learning. Thus, its influence will not always be neatly contained within events at the pupil-computer interface itself. Researchers … need to look further than this in defining the 'place' at which computers work their effects" (Crook, 1994, p9)*

The approach taken in this thesis has been to develop a common and holistic bridging framework based on different metaphor-informed perspectives on what a VLE is and how it is perceived, adopting different methodological techniques and instruments as the metaphor domain suggests. The use of metaphors to frame thinking about a subject or question is significantly influenced by the work of Lakoff and Johnson (1980) in questioning the objective and literal realities of social constructs and by that of Morgan (1997) in applying a continuum of metaphorical models to exploring the nature of organisations.

Multiple method approaches to research and evaluation are increasingly used in what has been dubbed the pragmatist paradigm (Tashakkori and Teddlie, 1998), using different techniques appropriate to the problem or question in hand. There are a variety of approaches that fall into this category; triangulation (the cross-referenced combination of a number of sub-studies) (Denzin, 1978), cascade studies (an aggregation of practitioner perspectives and other components) and holistic approaches based on concepts such as grounded theory (Glaser and Strauss, 1967; Strauss and Corbin, 1998). This thesis will make use of a number of aspects of grounded theory.

The original premise of grounded theory was to allow theory to emerge from inquiry (Glaser and Strauss, 1967), rather than using inquiry to confirm or disprove a pre-existing theory. Although some preliminary themes of interest have been identified in the preceding two chapters, there are no pre-existing theories regarding VLEs that this work is seeking to prove. It is one of the aims of this work to create a theory or a model that emerges from the use of multiple methods. The use of triangulation and grounded theory will be revisited and expanded upon in chapter 11.

In a mixed approach methods may be of equal status or one might dominate over the others used and there are a number of different ways that methods might be combined (Cresswell, 2003, p16):

- Sequential studies where different methods are used one after another, either independently or where subsequent methods elaborate on the previous method
- Concurrent studies where different methods are used at the same time
- Transformative studies that use a 'theoretical lens' to organise the choice and aggregation of research methods

The selection of appropriate evaluation methods for a VLE will determine the form and quality of evidence gathered. Regarding the research reported in this thesis, the use of metaphor to structure the overall evaluation acts as a theoretical lens and individual analyses have taken place both sequentially and concurrently (this is expanded upon in chapter 11).

3.2: Metaphor

Metaphor is to comprehend one thing in terms of another. Although it has been long established as a linguistic phenomenon and a tool of artists and poets, metaphor has recently been found to have a neurological basis, establishing it as a phenomenon that is a fundamental part of human experience, building and informing the way we experience and conceptualise the world around us (Lakoff and Johnson, afterword to second edition 2003, p256).

Lakoff and Johnson distinguish between primary and secondary metaphors. Primary metaphors are culture-independent and are based on fundamental experiences that arise from our embodied selves. Examples of these embodied primary metaphors include 'affection is warmth' and 'knowing is seeing'. Secondary metaphors are complex aggregations of primary metaphors and sociocultural experiences and are usually therefore culture-specific. Examples of these include 'argument is war' and 'poverty is sickness'. Whether primary or secondary, the metaphors we use systematically structure our understanding of the world, constraining it and flavouring it with derived associations.

The use of metaphor is often adopted to model and explain complex and novel phenomena. Thus the Internet is often considered to be a web, websites to be places and computers to be servants, though in reality they are none of these things. A metaphor may therefore contradict aspects of the reality of the subject; unlike war, arguments rarely lead to death and destruction. There may however be many less obvious associations and therefore expectations and values derived from metaphors that inform the way we see the world but that may not correspond with it, and indeed may not correspond with what different individuals perceive it to be. For instance, if knowing is literally seeing then how are special effects in films understood and how can blind people know anything if they cannot see? Our metaphorical understanding of the world is therefore less rational than we often think and much that is considered to be self-evident is often no more than shared and orthodoxical metaphor-informed experience.

Metaphor has been considered too mutable and subjective to be of any reliable use in objective studies and analysis. For instance, Schwier comments that metaphors are:

> *"indistinct—a farrago of ideas that can lend as much confusion as clarity. Even good metaphors, unless tethered, add little to our understanding … all metaphors are limited. At some point, they fall apart, and we are left with the task of discarding the metaphor and making a lunging transition to the original concept. Good metaphors permit deeper associations than poor ones, but all metaphors are shallow when compared to their referent ideas" (Schwier, 2002)*

Although this may be the case with simple concepts, it is with more complex concepts or aggregations of concepts that are interlinked and interact with each other that metaphor can shed light on the underlying cognitive models we have and how they interact to shape our understanding of these complex situations. Emerging over the past two decades, and originating in linguistics, the use of metaphor, as a focus of academic thought and as the basis for philosophy and investigation, has grown into a new field of 'metaphor theory'. Primarily built around the work of George Lakoff and based on empirical studies, metaphor theory has established that:

> *"metaphorical thought is unavoidable, ubiquitous and mostly unconscious … our conceptual systems are not consistent overall, since the metaphors used to reason about concepts may be inconsistent [and] we live our lives on the basis of inferences derived via metaphor" (Lakoff & Johnson, afterword to second edition 2003, p272-273)*

The use of a metaphorical perspective therefore challenges the objective literal understanding of the world around us. In particular it challenges the way we perceive our actions, our tools, our motives and our values. The use of metaphor as a means to explore otherwise complex human-oriented phenomena is therefore expected to gain insights and yield understanding of these phenomena that a traditional objectivist view cannot provide.

In that the VLE problem space is large, complex, and emergent, and is intrinsically tied to human constructs such as education and technology, metaphor has been employed as the basic currency of this thesis to explore and unpick the VLE problem space and to explore both the coherent and contradictory nature of metaphorical models of VLEs.

3.3: Metaphorical Domains

Lakoff and Johnson have identified 'primary metaphors', which are derived from essential embodied human experience, and 'secondary metaphors' constructed from primary metaphors and tied to specific sociocultural experiences and norms. Their work is fundamentally focused on the linguistic nature of metaphorical concepts and how they frame our thinking and understanding of the world. Their basic approach is to state metaphorical concepts and then deconstruct what these mean and entail. For instance, the metaphor TIME IS MONEY is derived from statements such as 'she's wasting her time' and 'I spent a week typing'. If time is commodity then it can be spent, saved, earned, given away, lost and so on.

Lawler (1999) (Lawler, 1999) defines three levels of metaphor:

1. Metaphor as a human cognitive phenomenon
2. Individual metaphor themes
3. Instantiations of metaphor themes

So TIME IS MONEY is an individual metaphor theme and 'I spent a week typing' is an instantiation. Instantiations of metaphors may take many different forms. The most used, and often therefore the most apparent, are linguistic in nature, expressed either in writing or in speech. However the relative volatility of speech compared with written text may obscure the extent of their use in verbal communication and therefore their impact on how we think and act. Certainly positivist academic literature will tend to consciously avoid metaphor in favour of what is perceived to be scientific and acceptably objective. Metaphors are also commonly instantiated visually, for instance in human-computer interface design or in information design such as that found in maps, signage and other graphical systems.

Metaphors can be somewhat like the concept of 'memes'; self-replicating ideas and concepts that pass from one mind to another by the means of imitation (Blackmore, 1999). An individual's metaphorical models and expressions may be passed on as memes if they resonate with their colleagues' primary metaphors. They may thereby spread through a community, reframing its collected understanding of the metaphors' referent topics. An example is Laurillard's adaptation of Pask's theories into her 'conversational framework' of the learning process (Laurillard, 1993); a model that has dominated a good deal of VLE theory and evaluation through its inclusion and prominence in both the first and second iterations of Britain and Liber's 'A Framework for the Pedagogical Evaluation of Virtual Learning Environments' (Britain and Liber, 1999; Britain and Liber, 2004). Framing learning as a conversation implies a binary exchange and negotiation around common purpose and activity. It therefore implicitly excludes the learning of the autodidact and the experiential learning of both individuals and communities.

3.3.1 Metaphor in Education

There is as yet no absolute knowledge or understanding of what learning is or how it occurs (although much research continues to pursue the problem). In the absence of a single objective essence and causation of learning, the ways that learning has been framed have been metaphorical in nature:

- The behaviourist model considers learning to be a causal result of external stimulus [LEARNING IS CONDITIONING].
- Cognitivism considers learning to comprise of the acquisition or reorganisation of mental processes [LEARNING IS ORGANISATION]
- Constructivism considers learning to be an internalised process of building new learning on top of existing learning [LEARNING IS BUILDING]. It is interesting to briefly reflect that if metaphorical thinking is based on modelling the unknown and unfamiliar in terms of the known and familiar then it is an intrinsically constructivist phenomenon.
- Sociocultural models consider learning to be socially mediated and constructed [LEARNING IS PARTICIPATION].

'Learning styles' is another dominant model for addressing learning that is essentially metaphorical in nature. The concern here is what learning styles students adopt; for instance surface, deep or strategic (Entwistle, 1984). Surface and deep learning seem to imply metaphors such as LEARNING IS IMMERSION or LEARNING IS A VOLUME, while strategic implies LEARNING IS A CAMPAIGN or LEARNING IS A GAME.

The sociocultural organisation of learning processes is also often metaphorical in nature. For instance students may be conceived as recipients, or consumers of education, while teachers may be conceived as content experts, facilitators or deliverers of the same. Each of these terms is metaphorically based and shapes the way we think about the role or the activity undertaken and therefore how it is going to be supported and valued.

It is easy to demonstrate therefore that many of our theories and approaches to education are intrinsically metaphorical and these metaphors shape the way we think about, present and conduct educational activities. It is probably worth differentiating the perspectives of the learner and the teacher at this point. While the teacher (and those who seek to assist and develop teaching) will often consciously try and understand how learning can best be achieved in their students, the individual learner will be less consciously involved in what the learning process is and will most likely be concentrating on learning itself. In formal educational encounters the environment the students find themselves in tends to be predefined and normative to the context at hand. In these situations any individual student is less likely to be constrained by their own metaphorical models of learning and more constrained by those of their teachers and their socio-cultural context.

3.3.2: Metaphor in Technology

Much technology is framed by metaphor, both in terms of how it is designed and how it is used. This is particularly the case with information technologies, where many basic concepts, such as the World Wide Web, are essentially metaphorical. In 'Metaphors We Compute By' Lawler examines technology metaphors of computer as servant, race, tool, machine, workplace, filing cabinet and toy (Lawler, 1999). Lawler also distinguishes between technology metaphors:

> *[There are] "metaphor themes that we use to approach computers as things and computing as activity. Some of these have Mythic status -- that is, they developed on their own, in the "cultural unconscious", and we have to deal with them, willy-nilly. Others are more or less conscious choices, made for particular reasons in particular contexts" (Lawler, 1999)*

Izwaini similarly looks at the computer as a living being, a workshop, an office, a building/place or a soldier and as the Internet as a road, a building/place, a book, a marketplace or a sea (Izwaini, 2003). He goes on to perform textual analyses of a body of IT literature to identify the key and most often used metaphors. He found that in literature discussing the Internet the most used key metaphors were Internet as Book and as Building/Place, and, as a percentage of use, Internet as Building/Place followed by as War and then as Book. For literature concerning computing in general the highest key metaphors were computer as Office and as Workshop while Building/Place was the lowest ranking term analysed. This would indicate there are differing models for understanding computing and the Internet and thereby different values associated with them.

Not only is metaphor a phenomenon of the way we think about and discuss technology, it is also a consciously used tool of those who design and implement technology. This raises a particularly important issue regarding the purposive use of metaphor:

> *"when confronted with a new piece of technology, such as a computer, for the first time people will often compare it to a machine with which they are familiar in a metaphorical way" (Preece, Sharp et al., 1994, p142)*

Computing makes extensive use of visual metaphor with elements such as the desktop, the trash bin, windows and files and folders familiar to all users. Websites and documents may have buttons and links and the use of icons is a whole field of activity in its own right. Using metaphor in developing technology is not without its critics however. Norman states:

> *"it is true that use of a metaphor is appropriate in the initial stages of learning. But while the first stages are only there temporarily, the metaphor is with us forever. After those first few steps of learning, the metaphor is guaranteed to get in the way, because by the very nature of metaphor the thing being represented by the other isn't the same" (Norman, 1999, p181)*

Pulkkinen splits technology metaphors into essence and container groups (Pulkkinen, 2003):

- Essence metaphors:
    - Substance: PC, technology, web, Internet, system, package, book, content, resource, software, product.

    - Instrument, tool: software, agent, tool, e-Mail, assisted, aid, support, enhanced, human beings as servants, assistants, agents.
    - Flow: electricity derived metaphors like e-Learning, conferencing, delivery, mediated, medium, enhanced, service, interface, presentation.
- Container metaphors:
    - 2-dimensional platform: platform, discussion board, on-line, web, Internet.
    - 3-dimensional space: cyberspace, virtual world, virtual school, environment, community, ecology, system.

3.3.3: Metaphor in Learning Technology

In that learning technology is a fusion of educational and technological domains, it would not be surprising to find that metaphorical models underpin many, if not all, learning technology materials and practice. Crook has employed the following metaphorical typology of learning technologies (Crook, 1994, p10):

- Computer-based Tutorial: this is where the computer is set up to direct the learner's activities and patterns of study. In this metaphor LEARNING TECHNOLOGY IS A TUTOR.
- Construction Metaphor: where the computer is set up to allow the learner to construct and represent their understanding back to the computer. In this metaphor LEARNING TECHNOLOGY IS A PUPIL.
- Simulation Metaphor: where the computer is set up to provide an environment for the learner to act within. In this metaphor LEARNING TECHNOLOGY IS A WORLD.
- Toolbox Metaphor: where the computer is set up to provide the requisite tools for the learner to learn without determining how they will be used. In this metaphor LEARNING TECHNOLOGY IS A TOOL.

Other dominant instances of metaphor in learning technology include:

- the conversational model of learning reified in Diana Laurillard's adaptation of Pask's work (Laurillard, 1993). In this metaphor LEARNING TECHNOLOGY IS A MEDIUM/CONDUIT.
- the concept of reusable learning objects (RLOs) where materials and activities are reduced to independent assets, for instance in Littlejohn (Littlejohn, 2003). In this metaphor LEARNING TECHNOLOGY IS A BUILDING SITE.
- the concept of online communities reified in learning environments and portals. In this metaphor LEARNING TECHNOLOGY IS A VILLAGE/COMMUNITY.

Metaphor is not only found in the use of learning technology and in its artefacts, it can also be found in patterns of its adoption and research. For instance Wilson et al have demonstrated three views of technology adoption, based on behaviourism, cognitive learning theory, and cultural studies (Wilson, Sherry et al., 2000) which are based on metaphorical models (see appendix 3.1).

Pulkkinen has related metaphors and metaphorical expressions of learning technology to their equivalent dimensions of research (see appendix 3.1). Pulkkinen's approach is particularly useful in that it assimilates learning technologies, their root metaphors and the dimensions of research into these learning technologies into a single model (Pulkkinen, 2003). It is not a perfect model however, as it really only addresses proximal issues and disregards the effects and impact of a learning technology beyond its sphere of use. Despite this, its combination of two axes (metaphor and research orientation) provides a basic metaphorically grounded triangulation grid, which could be adapted for evaluation and research into learning technologies.

3.4: Metaphor and VLEs

Because VLEs are likely to be the first large-scale online working environments their users have encountered there is a great degree of unfamiliarity and uncertainty associated with their development and use. From a research perspective this uncertainty can be addressed by analysing the metaphors relevant to the subject of study. There are various levels that metaphors are used in VLEs. These can be split into two broad categories or levels; *metaphors about VLEs* and *metaphors within VLEs*.

3.4.1: Metaphors about VLEs

The use of metaphorical language and allusion in describing VLEs is by no means new. The VLE is a complex phenomenon which, when deployed, exists in a mutually-dependent contextual relationship with the broader learning environment. Learning environments are themselves complex, partial and subject to metaphorical exploration, generating whole areas of research and evaluation themselves (Marton, Hounsell et al., 1997; Biggs, 1999). These metaphorical models can be split into formal and non-formal categories.

3.4.1.1: Non-formal VLE metaphors

Non-formal metaphors are those used without conscious regard to grounded theory or empirical evidence and are most often found in promotional literature or in speculative discussion. These metaphors seem to be the prevalent form, particularly among those who do not use VLEs directly, but provide them (vendors), have responsibility for procuring them (organisational managers) or discuss them on the behalf of others (advocates and consultants). A few examples include:

- Commercial VLE vendors' primary interest is in increasing their market share of systems/licenses sold, so it is not surprising that their product and marketing literature reflects the commercial orientation of their products. Two of the largest VLE vendors are WebCT and Blackboard, their names being themselves metonymic as they refer both to the company and to its products. WebCT represents itself as providing "enterprise-wide learning management solutions" and "a family of products and services that are being used to transform the educational experience of students around the world" (WebCT Inc, 2003). Blackboard describes its VLE as "tools and resources to successfully manage online, Web-enhanced, or hybrid education programmes" (Blackboard Inc, 2002) or as allowing "organizations to create convenient, comprehensive and cost-effective e-Education environments" (Blackboard Inc, 2001). While WebCT has tended to use the metaphors of VLE is a SOLUTION and VLE is TRANSFORMING throughout their literature, Blackboard uses VLE is MANAGEMENT as its dominant metaphor.
- There are also non-commercial advocates for VLEs, such as advisory and infrastructure providers. In the UK these include JISC[1], BECTA[2] and UCISA[3]. The JISC's MLE/VLE briefing papers (JISC, 2001) use language describing them as 'providing', 'supporting', and 'delivering', and having functions. This mostly addresses metaphors of VLE is SERVANT or ORGANISM and VLE is TOOL or MACHINE. BECTA is very circumspect in its language regarding VLEs and assigns no concept of agency or metaphor to them. Instead it treats them very passively, at most as systems or tools, and attributes effect and change to the institution and educational context (Hunt, Parsons et al., 2003). UCISA tends to echo the BECTA rhetoric (Browne and Jenkins, 2003) although both UCISA and BECTA defer to the JISC for definitions of VLEs.

3.4.1.2: Formal metaphors in VLE Literature

The terminology associated with VLEs is itself fundamentally metaphorical in nature but with major differences between the metaphorical associations that different terminology engenders. For instance the terms 'virtual learning environment' and 'learning management system' are often used interchangeably yet have very different implications. An environment is at its root a 'container' metaphor whereas a system is a kind of 'process/machine' metaphor. Phrased more directly, something that is virtual has associations of peripherality or insubstantiality whereas something that manages has associations of authority and control.

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[1] Joint Information Systems Committee

[2] British Educational Communications and Technology Agency

[3] Universities and Colleges Information Systems Association

In looking at these kinds of issues Wilson considers traditional underlying common metaphors for instruction such as classroom, product delivery, and systems and process and compares them with the use of an environment metaphor (1995) (see table 3.1).

If you think of knowledge as...	*Then you may tend to think of instruction as...*
A quantity or packet of content waiting to be transmitted	A product to be delivered by a vehicle.
A cognitive state as reflected in a person's schemas and procedural skills	A set of instructional strategies aimed at changing an individual's schemas.
A person's meanings constructed by interaction with one's environment	A learner drawing on tools and resources within a rich environment.
Enculturation or adoption of a group's ways of seeing and acting	Participation in a community's everyday activities.

Table 3.1: How different assumptions about knowledge can influence our views of instruction (Wilson 1995)

Wilson thereby associates the concept of learning environments with a constructivist perspective on instruction. Some examples of formal use of metaphors when dealing with VLEs include: VLE as cognitive apprenticeship (Brown and Duguid, 1995); VLE as conversation (Laurillard, 1993; Britain and Liber, 1999); VLE as cybernetic system (Britain and Liber, 1999); VLE as soft system (Koper, 2000); and VLE as community of practice (Ellaway, Dewhurst et al., 2004).

3.4.2: Metaphors within VLEs

Internal VLE metaphors, in that they are reified rather than socially constructed, are often more visible and prominent. They may be expressed at different levels throughout the VLE and the use of a high level metaphor may set in train lower level metaphors. For instance if a VLE is presented as a building then its components may well be presented as floors or rooms and its interfaces may well be presented visually using these associations and verbally using verbs such as ‘enter’ and ‘leave’.

While some VLEs may make strong and explicit use of metaphor, others may use it very sparingly, if at all. Returning to Norman’s observations that metaphor can be obstructive and misleading (Norman, 1999, p181), it may be that the use of more explicit metaphors is a phenomenon of early VLE developments and these are later abandoned in favour of more neutral approaches as systems become more established and able to more usefully be ‘themselves’.

- *Level 1: Architecture*: The architecture of a VLE may be metaphorically modelled. For instance the Strathclyde Virtual University used a campus metaphor with different parts of the system being represented as different buildings. Similarly the Nathan Boddington system represents itself as a building, and the coMentor VLE similarly uses area ‘metaphors’ throughout with a starting page called the ‘entrance hall’. Many of the big VLE vendor systems use an institutional architectural metaphor, which fits with the modular degree programmes of those institutions that use them. Blackboard for instance is divided into 'institution', 'courses', 'community' and 'services' sections. Other more specialist systems will use other architectural metaphors. The Edinburgh medical undergraduate system for instance has been developed as an 'electronic curriculum', a metaphor that is reflected in an architecture that is equivalent to the components of the curriculum.

- *Level 2: Components*: Many of the component services or functions within VLEs are also metaphorically modelled. For instance there are often 'discussion boards' or 'notice boards' which bear little resemblance to their pin board antecedents, there are sections providing resources which are made to look like libraries or checklists and there are many other variations on spaces and places. A possessive metaphor is often used for personalised pages, often in the form of 'my something or other', where the individual is encouraged to think of the system as giving them ownership and supporting their individuality in general.
- *Level 3: Interface*: The use of metaphor is very well established in human computer interface (HCI) design and most VLEs use familiar HCI metaphors such as pages, buttons and icons. At this level there is little to distinguish VLEs from other web sites and applications.

3.5: Metaphor as an Evaluative Paradigm

The 'theoretical lens' of this thesis is that by taking a series of metaphorical perspectives on VLEs, a coherent set of methods can be identified and applied to create a rich evaluation of EEMeC. How then might a suitable range of metaphors be identified? How many should be used and how can this be suitably grounded in theory and practice?

The framework adopted for this thesis is adapted from the organizational metaphor analyses presented in 'Images of Organization' (Morgan, 1997), This key work in the field of organizational and management theory takes a series of metaphorical stances from which theories of organization and management can be developed. Morgan's approach is not intended to give exhaustive and absolute answers, but rather that a range of metaphors are used to illuminate, both in terms of their individual and combined strengths and weaknesses, and thereby open new ways of understanding complex situations. The metaphors that Morgan adopts are:

- ORGANIZATIONS are like MACHINES
- ORGANIZATIONS are like ORGANISMS
- ORGANIZATIONS are like BRAINS
- ORGANIZATIONS are like CULTURES
- ORGANIZATIONS are like POLITICAL SYSTEMS

- ORGANIZATIONS are like PSYCHIC PRISONS
- ORGANIZATIONS are like FLUX AND TRANSFORMATION
- ORGANIZATIONS are like INSTRUMENTS OF DOMINATION

Note that for the purposes of this thesis the evaluation of politics and domination have been conflated as being very similar in the way they inform metaphor-based evaluation as politics can be considered as the exercise and negotiation of power and domination within a system. Morgan is clear about the limitations of taking any particular metaphorical perspective however:

> *"any given metaphor can be incredibly persuasive, but it can also be blinding and block our ability to gain an overall view" (ibid, p347)*

A single metaphorical model runs the risk of binding subsequent actions and development to that perspective alone. Morgan's methodology is to move through two stages of analysis. The first stage is to 'diagnose' a problem from a number of metaphorical perspectives; the second is to work them into a single 'storyline' that encompasses the multiple perspectives in a single narrative. The author of an analysis is identified within their analysis as their perspectives cannot help but be a major factor in the resulting evaluation.

Morgan's approach has had both critics and those that have extended his ideas. Some have criticised Morgan for combining both familiar and unfamiliar metaphors, the former considered over-resonant, the latter weak by dint of their unfamiliarity (Mangham, 1996), others have considered Morgan's approach to be too static (Chia, 1996), or have rejected the metaphorical approach altogether (Tsoukas, 1993). What is common to Morgan's adherents and most of his critics however is that metaphorical analysis provides a new and powerful approach to investigating and researching complex situations. It is mostly the extent of use, the approaches taken and their relation to the objectivist scientific tradition that raise concerns.

Morgan has effectively raised a direct challenge to the positivist tradition claiming that all concepts on which objective truths are built are themselves rooted in metaphor and ways of seeing the world:

> *"in recognizing that every view of the world has inherent strengths and limitations, an awareness of the role of metaphor has fundamental implications for how all knowledge should be regarded" (Morgan, 1996, p233)*

Objectivity is as metaphorically-based as any other human construct, and as such should be seen in a wider perspective. This emphasises the role of self-awareness and reflection in the researcher and the need to strive for more holistic perspectives on problem spaces. Morgan has also identified the inherent dialectical nature of metaphorical analysis with the thesis and antithesis components combining to give a Hegelian synthesis – the strengths and weaknesses to create larger and more complete views of the problem space. Placing his approach further within the scientific tradition he asserts that:

> *"metaphor [is] a distinctively postmodern concept that has an inherent tendency to deconstruct itself and the knowledge that it generates" (Morgan, 1996, p239)*

Morgan has therefore created a powerful and philosophically grounded approach to analysing complex organisational settings, which although not without limitations, has provided a link between concepts of soft systems, holism, triangulation and the many potential ways of looking at VLEs.

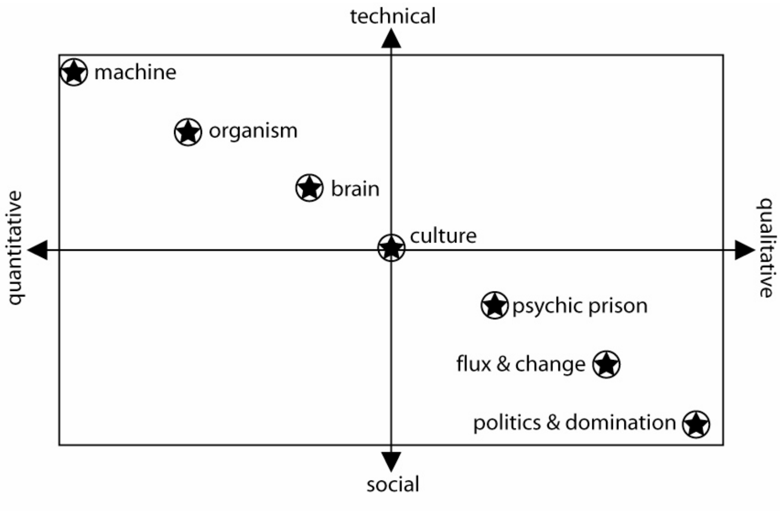

Figure 3.1: 'Morgan's metaphors' as a basis for considering VLEs, mapped to a biaxial continuum between quantitative and qualitative domains, and between technical and social domains.

'Morgan's Metaphors' were selected for this study for a number of reasons. They provide a link to theories regarding different aspects of complex social organisations and situations, they traverse the qualitative/quantitative and technical/social aspects of an organisation (see figure 3.1), and they have been explicitly linked to multiple methods techniques for evaluation and research. Morgan insists his choice of metaphorical domains was right for his own use, and that anyone attempting a similar project should consider those most appropriate to them. Despite this, the seven metaphors that Morgan uses to look at organizations would appear to map well to VLEs and have been tested and proven in use. Although other metaphorical perspectives on VLEs are most certainly possible (see the next section), it is Morgan's seven metaphor perspectives that will be used as a 'theoretical lens' around which this research will focus.

While some of Morgan's metaphors may seem quite relevant to VLEs (machines, cultures, flux and change) others are less clear (organism, brain) and at least one quite dissonant (psychic prisons). It was decided to adopt Morgan's metaphors 'as is' so that, other than conflating 'political systems' and 'instruments of domination', Morgan's names and themes for his organisational metaphors were retained throughout. The intention was to retain the dialectical tensions between the subject and object of all the metaphor-informed perspectives so that even when the metaphor might seem incongruous it could be used to stimulate thinking and reflection as to what questions might be asked and what kinds of information and knowledge gained. The next section briefly investigates the congruity and acceptability of different metaphor perspectives to EEMeC amongst members of the EEMeC user community.

3.6: Metaphorical Resonance

As a preliminary investigation, the perceptions of members of EEMeC's user community were surveyed regarding metaphors associated with EEMeC. The sample consisted of 13 staff; a mixture of teachers, administrators and EEMeC developers. Each respondent was presented with a list of 59 metaphorical statements regarding EEMeC (see appendix 3.2) and was asked to agree or disagree with each in turn. The metaphors were selected from the literature and themes already pursued in this chapter to encompass a wide range of options (although they were not an exhaustive selection). An additional option was given to the respondents to record any other metaphors they felt were appropriate but absent from the list.

If a respondent agreed with a metaphorical statement then a score of +1 was recorded, if they disagreed then -1. If they actively indicated equivocation then a 0 was registered, otherwise a null score was given. A mean for each statement was taken and a frequency graph plotted (figure 3.2) which shows that there is a fairly even distribution of statement scores, indicating that the statement list encompassed a reasonable range of positive, neutral and negative statements for the respondents sampled. Note that in order to do any further statistical work with the data, medians were used rather than means.

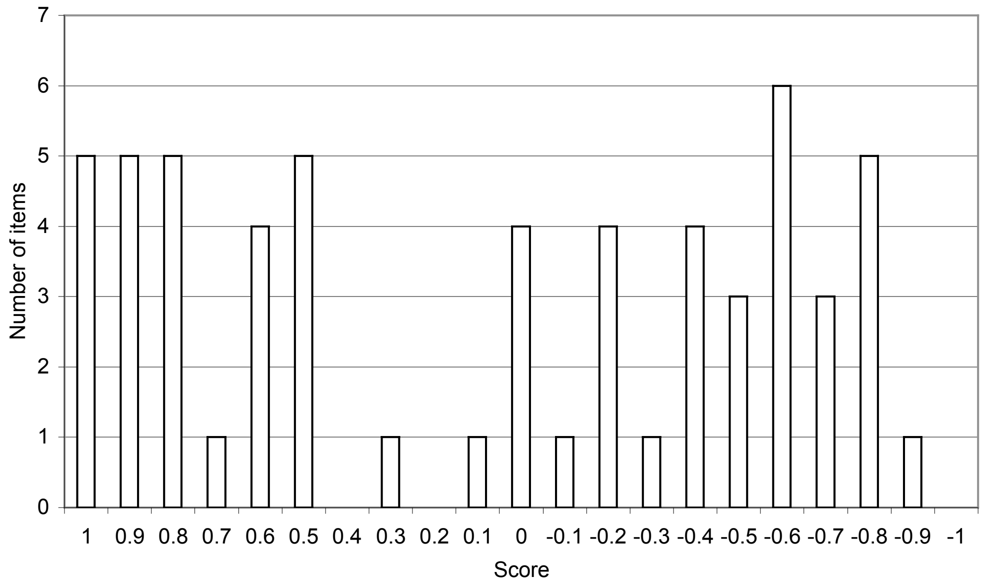

Figure 3.2: distribution of median scores for EEMeC metaphor statements

Table 3.2 shows the ten highest and ten lowest scored metaphors. The highest ranked metaphor was 'EEMEC is an OPPORTUNITY' which is interesting in its associations with potentiality and aspirational associations. The rest of the higher ranked metaphors seem to indicate dominant ideas of EEMeC as conduit and container, while the lowest ranked metaphors seem to suggest that EEMeC as a person or an entity were rejected.

Although these interpretations are interesting, something a little more substantive was required. Returning to the concept of root metaphors, each statement was associated with one of a selected range of root metaphors (predominantly from Lakoff and Johnson (1980)) and median scores taken for the component statements for each root metaphor. The results are shown in table 3.3.

Most Popular Metaphors for EEMeC	**Least Popular Metaphors for EEMeC**
EEMEC is an OPPORTUNITY	EEMEC is a BUILDING
EEMEC is a SYSTEM	EEMEC is a THREAT
EEMEC is a MAP	EEMEC is a COLLEAGUE
EEMEC is a MEDIUM	EEMEC is a TYRANT
EEMEC is a TOOL	EEMEC is an IRRIGATION CHANNEL
EEMEC is a SERVICE	EEMEC is a PRISON
EEMEC is a CHANNEL	EEMEC is a COUNSELLOR
EEMEC is a STORE	EEMEC is DOMINATION
EEMEC is a RESOURCE	EEMEC is a BRAIN
EEMEC is ELASTIC	EEMEC is a PUPIL

Table 3.2: ten highest and lowest ranked EEMeC metaphor statements.

Root Metaphor	**Number of components**	**Median component score**
Conduit	5	11.00
Container	12	2.00
System	6	2.00
Activity	10	-1.50
Substance	5	-3.50
Person	12	-4.00
Tool	9	-4.00

Table 3.3: EEMeC evaluated root metaphors, their components and their median component scores in score rank order

Although this is still far from constituting strong statistical evidence it is interesting at this stage to note that the (small) sample group reacted positively to EEMeC as a conduit, a container and a system, and negatively to it being an activity, a substance, a person or a tool. One interpretation might be that users of EEMeC consider the value and substance of the course to be other than in EEMeC, with its role predominantly being one of supporting these other dominant aspects. The results of repeating this process for the seven root metaphors used by Morgan is shown in table 3.4.

Root Metaphor	**Number of components**	**Median component score**
Organism	5	8.00
Culture	9	7.00

Machine	14	6.00
Prison	6	3.50
Brain	14	0.50
Political	7	-2.00
Flux	4	-4.00

Table 3.4: EEMeC evaluated root metaphors from Morgan, their components and their median component scores in score rank order

This second analysis shows a more even spread of median component scores than the first as well as a positive skew (the first set had a negative skew). This indicates that this is a slightly more useful analytical model than the first and is able to provide a reflection upon Morgan's metaphors. Organism, culture and machine were the three highest ranked metaphors for EEMeC, prison slightly lower, brain fairly neutral and politics and flux ranked much lower. There are many possible reasons for this, some of which may have very little directly to do with EEMeC, and such speculation is of limited value at this stage. Since one of the success criteria for an evaluation is related to its relevance and meaning to specific user communities (Weiss, 1988; Oliver, 2000), this mapping to Morgan's metaphors provides an indication of which of the metaphor-based evaluation methodology groupings are likely to be most acceptable and relevant to the immediate VLE user communities. This issue is reprised in chapter 11.

3.7: Discussion

The previous chapter outlined a problem space for VLEs as being made up of technology, systems, education and context. This chapter has described the development of a general research methodology based on a series of metaphor-informed perspectives derived from the work of Gareth Morgan. In respect of the use of metaphor in learning technology research it has been observed that:

> *"in everyday discussion it may sound rather trivial to discuss whether we should consider the concepts of tools, media, learning environments, information systems or virtual universities. If we look at these conceptual metaphors more closely, we can realize that they are connected to ontological differences in research assumptions and different paradigms of research … further empirical research is needed to explore the internal logic of the emergence of these metaphors and research paradigms in order to understand the development of multidisciplinary research domains" (Pulkkinen, 2003, p147)*

The work in this thesis is presented in part to address the questions of how thinking about questions and problems framed as metaphorical perspectives can relate to research and evaluation. Having established a metaphor-informed evaluation framework in this chapter, subsequent chapters will explore each of Morgan's metaphor perspectives, relating each to existing literature and research, and exploring how useful they are as a practical starting point for conducting evaluations of a VLE-in-use.

Chapter 4: VLEs as Machines

4.1: Introduction

VLEs are, in one sense at least, undeniably 'machines'; they are purposively designed and built, they have reified software and hardware components and they can exist in this form independent of use.

This chapter uses the first of Morgan's metaphors to consider VLEs from the perspective that they are machines. If a VLE is treated as a neutral entity, that has causal and intrinsically objective interrelationships with its environment and users, then this is a mechanistic perspective. In a truly mechanistic scenario a VLE should be able to be plugged in, switched on and left to run with predictable results. Furthermore, the objectivist imperative in a mechanistic perspective implies that such a perspective should be of a spectator sitting outside the system and its users.

In a little more detail, a mechanistic perspective is indicated in the following scenarios:

- The VLE is predominantly treated as a technical system of software and hardware components. This is often the position taken by institutional computing services and those who have responsibility for the purely technical aspects of a VLE.
- The VLE is predominantly treated as if it was the sum of the functions and services it offers, affording causal benefits to its users and to the institution. This is often the position taken when a VLE is being selected or comparisons are made between VLEs by senior and/or central institutional managers.
- The VLE is predominantly treated as a system through which students (and to a lesser extent staff) are processed – i.e. the VLE is the means by which aspects of the institution's core business will be achieved; students, content and staff are in effect the raw materials that the VLE processes into graduates.

Methodological approaches to evaluating a VLE from a machine perspective can take a number of different forms. For instance machines have specific structures, they have measurable technical properties, they have component parts and they have inputs and outputs. In terms of a VLE its structure can be considered in terms of its system architecture, its technical properties can be considered by looking at its code using software metrics, its components can be iterated using checklists and inventories and its inputs and outputs can be measured using the logs that it keeps of this traffic.

4.2: System Architecture

The architecture of any system describes its components and the relationships between them. As has already been discussed, a VLE has both software and hardware components that go to make up its architecture. This section provides both descriptions of EEMeC's architecture and an investigation of formal methods for evaluating architecture.

4.2.1: Internal Architecture

EEMeC is a typical n-tier VLE system (discussed in chapter 2) (see figure 4.1).

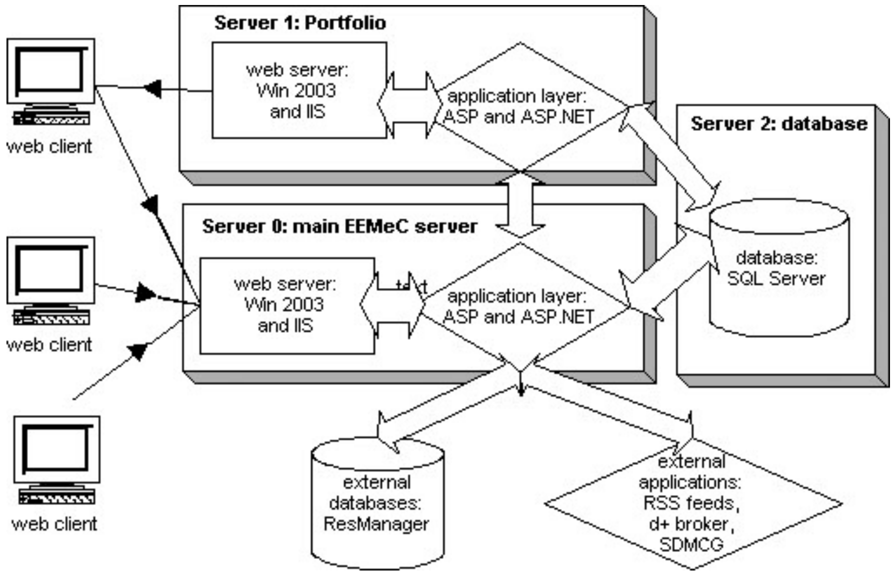

Figure 4.1: EEMeC system architecture. EEMeC works across three servers, a front-end web and application system (server 0), a secondary web and application system (server 1) and a separate database server (server 2). The servers are Dell computers running Microsoft 2000 Server or Microsoft 2003 Server. The web layer is Microsoft Internet Information Services (IIS), the application layer is based on Active Server Pages (ASP/ASP.NET), and the database is based on Microsoft SQL Server 2000. A number of COM component extensions are used for uploading files, converting files to PDF format, processing email, handling XML and creating and managing files on the server.

4.2.1.1 Client level

EEMeC is accessed via the Internet. To run on a web browser EEMeC requires both cookies and JavaScript to be enbled and thus it excludes some older or less common browsers. Some functions also require pop-up windows, but as many browsers now have a function to suppress them (as many contain unwanted adverts) this can be problematic. EEMeC also uses secure sockets layer (SSL) certificate-based encryption between the client and the server for security of transactions.

Client problems experienced include:

- *Browser fall over*: as some of the EEMeC pages are large and the functionality sometimes complex, some earlier browsers (and some newer ones) have proved unstable when using this extended functionality.

- *Unsupported operating systems*: as EEMeC works using standard HTML, there should be no platform dependencies. There are some idiosyncrasies in developing in ASP and JavaScript, which are platform-specific however, and there has been at least one student with an Acorn computer that couldn't use the web at all.

- *Hospital firewalls*: as many students access EEMeC from hospital networks the firewalls between these networks and the web can often cause problems, particularly when trying to set cookies on a client browser.

- *Plugin dependency*: in addition to the general technical requirements already discussed, a number of (free) plug-ins or browser extensions are required in order to use the variety of media types in EEMeC. These include Macromedia Shockwave, Adobe Acrobat and Real Media Player. For machines that are locked down against users installing software, for instance in open-access student computers and for hospital-based terminals, this can also create problems, while the size of some of these downloads can be problematic for those with a slow dial-up connection.

- *Screening software*: students with computers provided by their parents may have screening software against offensive and pornographic websites. These have caused some EEMeC information to become jumbled, as lumps of code containing student banter or gynaecological terminology are arbitrarily removed.

4.2.1.2: Application level

As indicated in chapter two, the programming and functionality of a VLE primarily rests in its application and database levels. In EEMeC there are a number of functional modules that are attached to the core as indicated in figure 4.2.

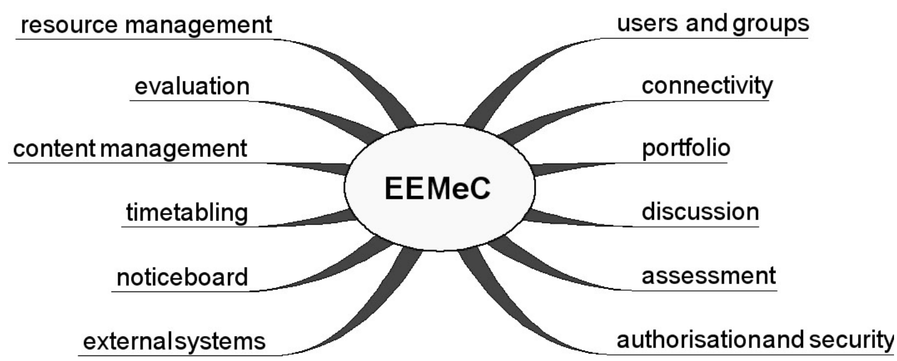

Figure 4.2: basic areas of functionality within EEMeC

Some modules provide services to the others, in particular ‘authorisation and security’ and ‘users and groups’, while others provide direct functionality to users.

4.2.1.3: Database level

EEMeC uses Microsoft SQL Server 2000 to provide its database functionality. SQL Server is a relational database management system that provides both data storage and transaction management. The EEMeC database design is one of its most important aspects as all of the other layers are dependent on the information that it provides.

At the core of the database are two constructs on which the rest of the system depends; the user core and the content core (see figure 4.3).

The User Core: is a combination of four sets of data; users, groups, permissions and usertypes.

- ‘Users’ holds information about each VLE user, in particular their login name and password, their first and last names, and other individual user data.
- ‘Groups’ holds information about all of the aggregations of users; principally student groupings.
- ‘Usertypes’ holds information on what permissions and rights there are within the system
- ‘Events’ holds information on the various time-based events and the periodicity of the course so that academic sessions are distinct from each other

When these tables are joined together the following kinds of information can be constructed:

- which user or group has rights to what information and resources
- which user or usertype is a member of which group
- which users or groups participate in which events and when

The Content Core: is responsible for content management and rendering. All pages in EEMeC are, unless they are specific tool pages, based on a node model (see appendix 9.4). Using a nodal architecture effectively separates the systems topology from its content allowing each to be managed independently from the other. For instance if a topic changes its place in the course then its corresponding nodes can be disconnected from the old location and attached in the new location or when study guides are refreshed for a new academic session their links can be retained even when the content is changed.

4.2.2: External Architecture

As a VLE is intrinsically based on a client-server model, the client and the server must be connected to and able to communicate across a shared network. This is almost always achieved using standard Internet and web protocols, commonly based on HTTP over TCP/IP. EEMeC conforms to this pattern.

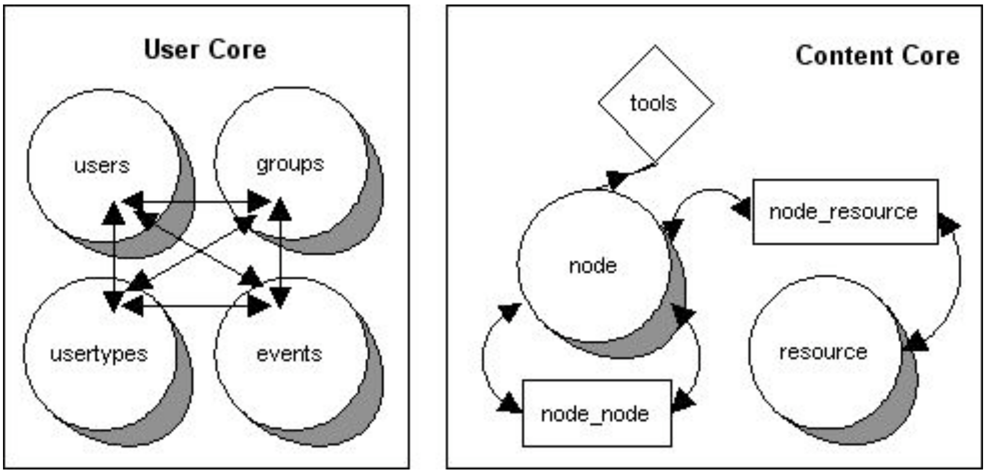

Figure 4.3: core components of EEMeC's database design

The EEMeC servers are connected to the University of Edinburgh network which has a major gateway to the UK educational network backbone of SuperJANET, which in turn is connected to the Internet. EEMeC also uses ODBC connectors to its database server and SOAP and other XML-based protocols to communicate with third-party systems and services. Client access is by HTTP web connection open to anywhere in the world. Client technologies required are certificate-based secure sockets layer (SSL), cookies, stylesheets (CSS) and JavaScript as discussed in section 4.2.1.1.

4.2.3: Evaluating VLE Architecture

4.2.3.1: Unified Modelling Language

An increasingly commonly means of expressing system architecture, function and use in software development is to use Unified Modelling Language or UML. Developed by the software industry, UML is intended to specify, visualise and document systems by providing formal visual models for representing system structure and system behaviour (Object Management Group, 2004). Although this was principally developed to support formal and large-scale software development, UML has been identified as having a wider range of uses (Fowler, 2004):

- Sketch: representing selected aspects of a system, either as part of a development process or as 'reverse engineered' models of an existing system

- Blueprint: representing a complete system
- Programming language: executable code can be directly generated from UML models

EEMeC is a large and complicated system and generating a full UML blueprint would more than fill a work the size of a thesis. For the purposes of this chapter, a number of UML sketches have been generated, employing a range of diagram types as an illustration and as a means of reviewing UML as an evaluation methodology, but without providing a comprehensive and exhaustive UML representation of the EEMeC as a whole. Four diagram types have been selected as representing progressively more detailed aspects of the system; deployment, package, class and activity diagrams.

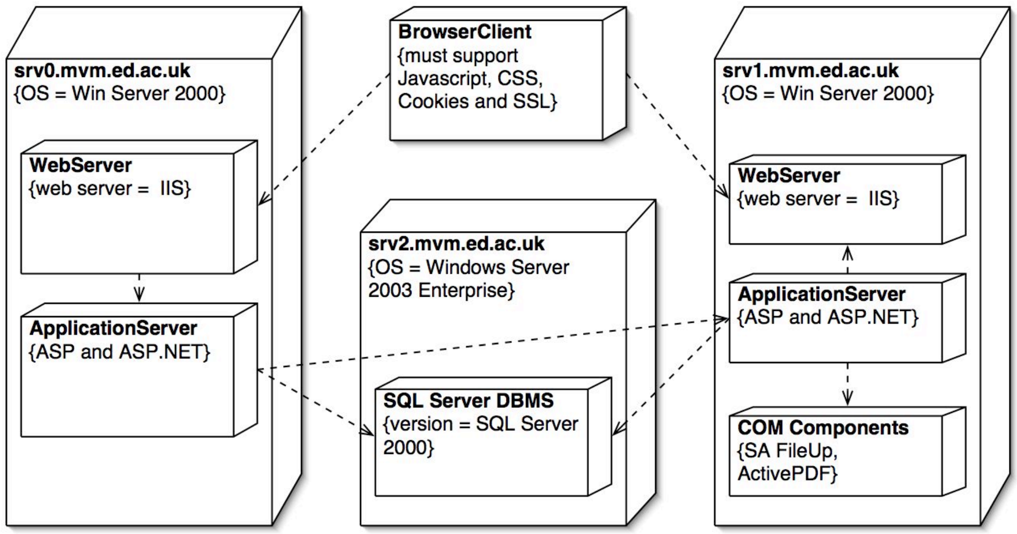

Figure 4.4: UML Deployment Diagram of EEMeC's main server architecture

4.2.3.2: Deployment Diagrams

A deployment diagram is intended to show the physical layout of a system. Figure 4.4 is a UML deployment diagram of EEMeC. The diagram indicates the n-tier architecture spanning the client, the two web and application servers and the database server. The diagram also includes details of the servers' operating systems and the principal software components of each within the EEMeC context. What are not indicated are the third-party web-service components that extend the local system's functionality, there is nothing preventing their representation in this model.

Such a representation would allow an informed evaluator to assess the system in terms of known or perceived qualities of the broad hardware and software components of the system, their interconnectedness and their compatibility. However, none of these is necessary particular to the system (VLE) under consideration; EEMeC shares the architecture depicted in figure 4.4 with a number of other web applications.

4.2.3.3: Package Diagrams

The UML package diagram is intended to show the general components or units within an application. A general representation of EEMeC's principal parts was shown in figure 4.2; a UML equivalent is shown in figure 4.5. In addition to the components, the arrows indicate dependencies between components. The diagram shows for instance that all functions are based on a user's rights or rights pertaining to the user based on their membership of different groups, and a common security and rendering model. Although EEMeC is a modular system based on common user, security and rendering functionality this diagram does not indicate how this works.

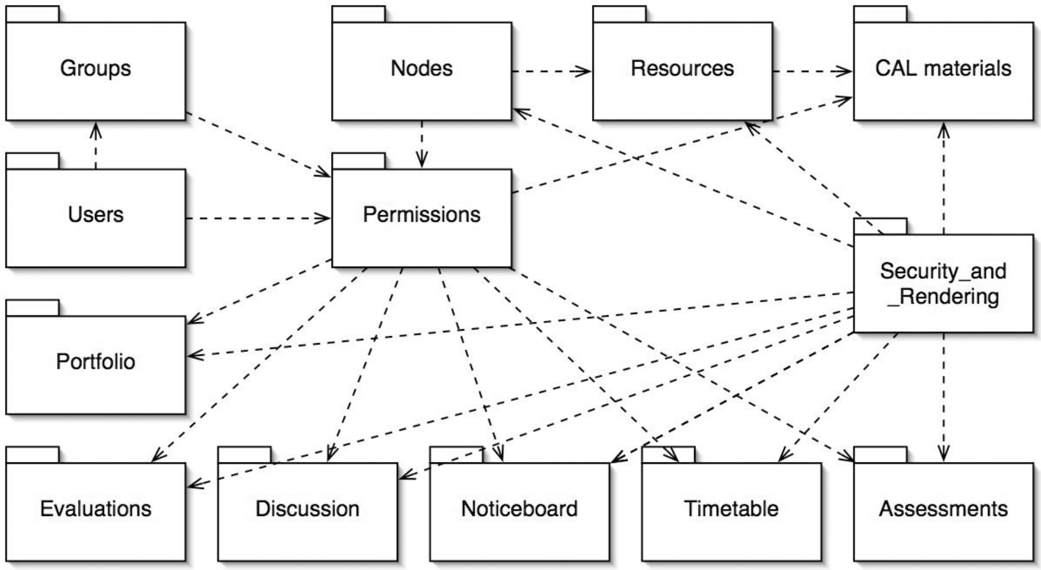

Figure 4.5: UML Package Diagram of EEMeC's principal component modules

4.2.3.4: Class Diagrams

Class diagrams describe system objects and the static relationships between those objects. If the various packages in figure 4.5 were to be expanded then one or more class diagrams would serve to render their contents. Figure 4.6 shows just such an expansion for the 'Users' and 'Groups' packages in figure 4.5.

In this case each of the class objects represents a database table and the arrows indicate generalisation (for instance between 'Student' and 'AllUsers'), associations with cardinality (for instance between 'Staff' and 'Staff_UserTypes') and dependencies (for instance between 'StudentGroups' and 'Groups'). The diagram uses the attributes slot to indicate the primary keys that tie the tables together and that are passed into the application layer. The diagram shows that membership of a year and a group is handled separately, that users are split into a basic staff or student identity and thereafter handled separately and that the main join between the two is where a member of staff is a director of studies for a student (as shown in the 'Student_DOS' join table.

A notable limitation of a class diagram is its modelling of static objects and properties. The diagram does not show runtime behaviour, flow or sequencing and does not indicate the creation and aggregation of temporary data objects that an application creates as it runs. The predominance of this diagram type in UML is an indication of its orientation towards object-orientation (OO) where object/class generation and management is of particular importance. EEMeC is a web application and splits its functionality between the application layer and the database layer. Furthermore it is predominantly written in ASP, a 'scripting' rather than a programming language. This means that EEMeC's code does not have an explicit compilation stage in its development but is dynamically interpreted at runtime. EEMeC's code is developed organically and fairly linearly and the application consists of a number of semi-independent scripts rather than a single executable. Although OO methods are employed at times, their use is limited and thus class diagrams may be less useful for scripted systems like EEMeC than for programmed systems in general.

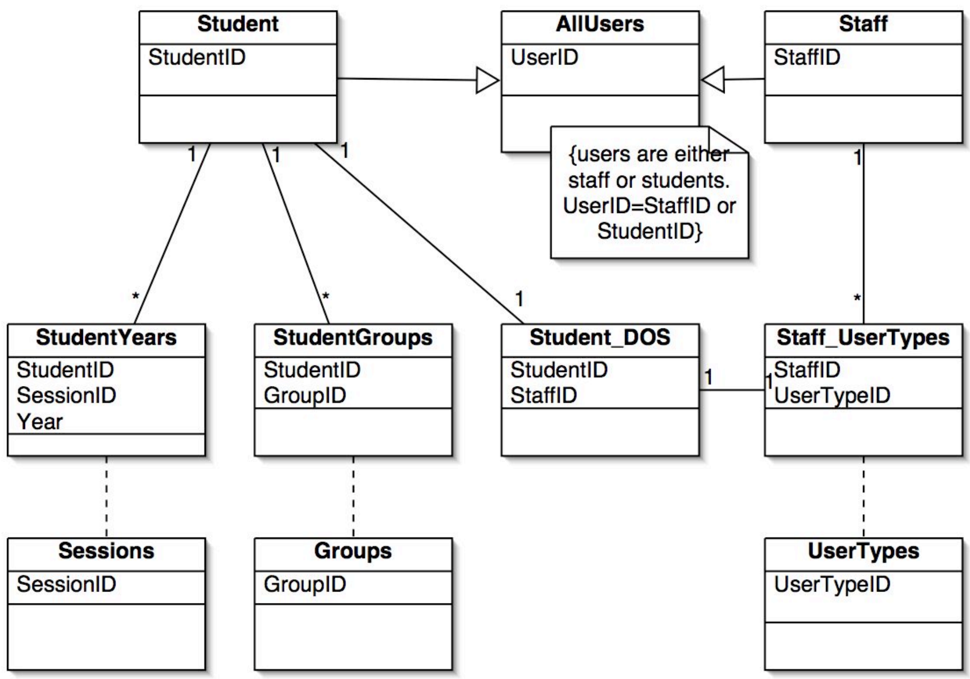

Figure 4.6: UML class diagram showing class objects covering EEMeC 'user' and 'group' packages described in figure 4.5

4.2.3.5: Activity Diagrams

A UML activity diagram represents the flow of a particular system process, showing both its logic and workflow. Figure 4.7 is an activity diagram representing the login process to EEMeC. It tracks the various different ways a user can try and access EEMeC and the login paths they are taken through. A major component of this process is the 'logpass.asp' script that performs the transactions with the database and sets the various cookies on the client browser. Figure 4.7a is second activity diagram showing the flow within the 'logpass.asp' script.

Of the four diagram types evaluated, activity diagrams are the closest to the actual code in an application. As such they can provide templates for other developers or act as a form of documentation for the application itself. However, they are still an abstraction or generalisation; the flow shown in figure 4.7 could be achieved in a number of ways.

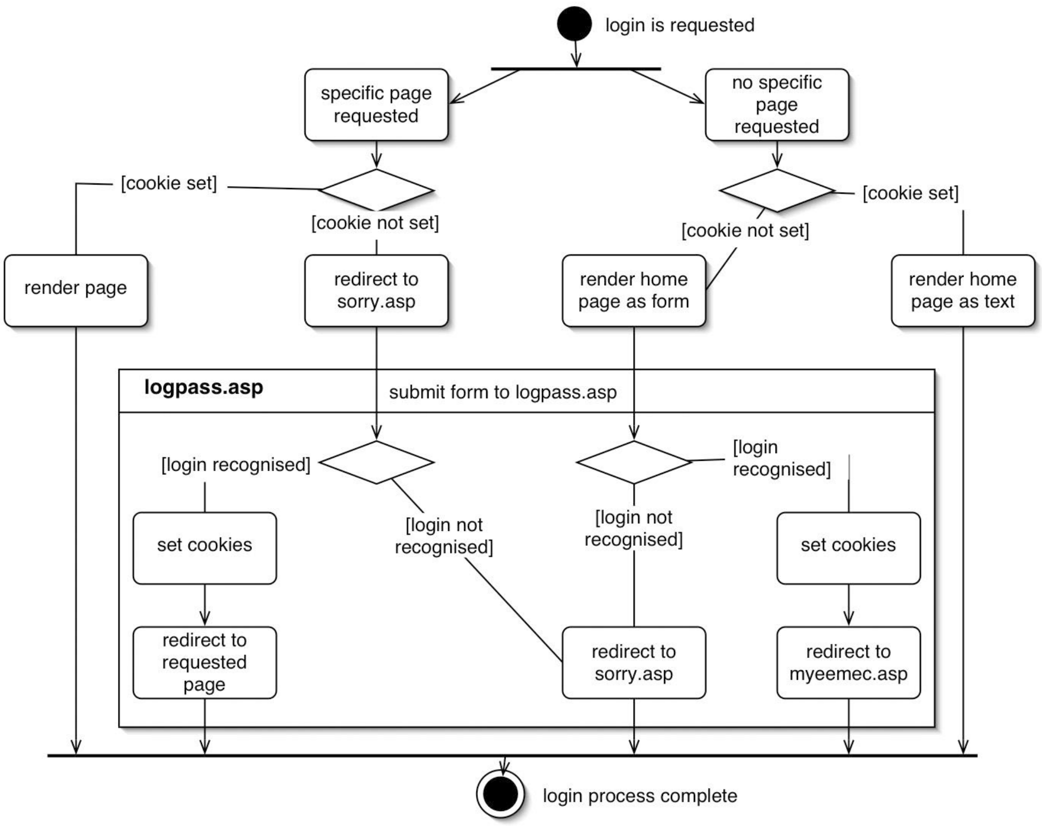

Figure 4.7: UML activity diagram showing login logic pathway for EEMeC

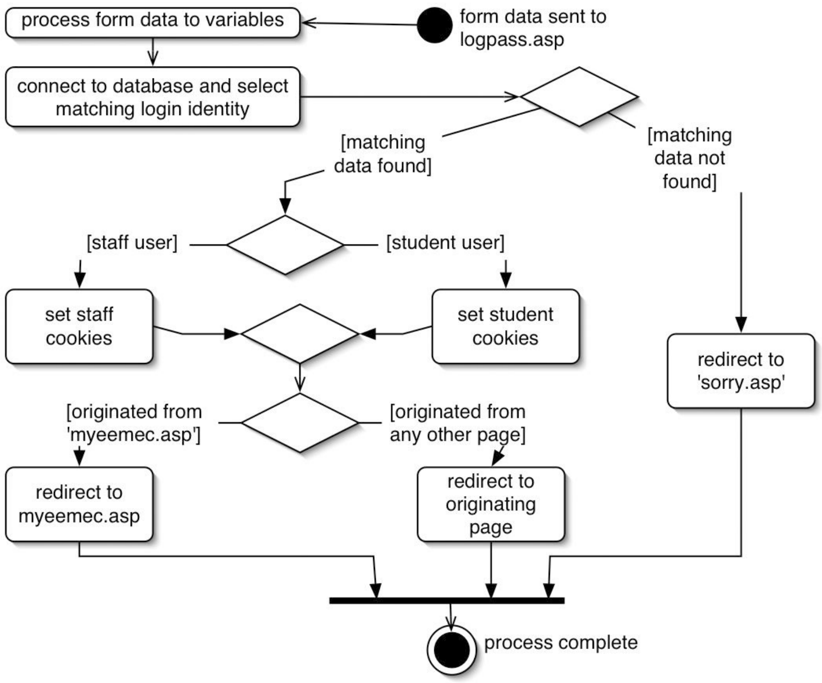

Figure 4.7a: UML activity diagram showing logic pathway for script 'logpass.asp'

4.2.4: UML as a Tool for VLE Evaluation

Although UML is commonly used in software development it is not without its critics. For instance, concerns have been expressed about its lack of completeness (Ambler, 2004). As a formal sketching system for EEMeC, UML has proved serviceable and able to represent different levels of system architecture. To cover all of EEMeC however would take a very large number of such diagrams; as such UML is not parsimonious. UML diagrams are an appropriate although time-consuming way to express the different levels of a VLE's architecture. As an evaluation methodology they are of limited use. Interpretation requires a good level of expertise, and without some kind of external metric any such interpretation is inevitably subjective. A more significant limitation is that detailed evaluation of a system's architecture is only possible if the evaluator has access to the architecture in the first place. Access to a commercial system's code and structure is likely to be limited or even impossible. Even open-source systems may contain compiled (and therefore locked) modules and classes. It has been possible to use an architecture-focused methodology when looking at EEMeC, because the author had unrestricted access to the system's code.

4.3: Software Metrics

The architectural approach to evaluating aspects of a VLE, described in the previous section, yielded a degree of useful information but in a mainly descriptive and interpretive fashion. If a VLE is a machine should it not be possible to measure aspects of its machine-like form and behaviour? Software engineering is a huge industry and many approaches to undertaking just this kind of approach have been developed within it. These approaches come under a general methodological concept of 'software metrics' and may include measures of cost and effort, productivity, reliability, quality, performance, structure and complexity, and capability and maturity (Fenton and Pfleeger, 1997, pp15-20).

4.3.1: An Overview of Software Metrics

There is no single discipline or practice of software metrics, rather there are many methods, models and analyses that have been developed to understand, control and improve software development processes (Fenton and Pfleeger, 1997, p13). Metrical analyses will either consider measures of the 'external' or the 'internal' properties of an application. External properties include reliability, usability, effectiveness and interoperability; many of which will be considered in later chapters. From a machine-oriented evaluation it is the internal properties of an application that are most important.

The GQM approach (goal – question – metric) (Basili and Weiss, 1984; Fenton and Pfleeger, 1997; Huber, 1999) is based on a three-step process, moving from defining the goals of the analysis, through creating formal questions to defining the metrics that can answer these questions (see table 4.1).

Goal	Question	Metric
For the purposes of this thesis find a way to measure the efficiency of key EEMeC components.	How efficient are the algorithmic structures in particular key scripts?	Lines of code, density, external calls
For the purposes of this thesis find a way to measure the complexity of key EEMeC scripts.	How complex are the structures of key scripts?	Path and graph analysis of algorithms.
For the purposes of this thesis find a way to measure the cost of the EEMeC development process.	What are the temporal and financial costs of development?	Estimations of development productivity and efficiency.

Table 4.1: goal-question-metric table for identifying software metrics for EEMeC

4.3.2: Size as Metric

Metrics of internal size are mostly based on analysis of the code in an application. The basic measure of lines of code (LOC) is most often used although it is important to state what it actually means in any particular analysis. In any application there may be blank lines left to render code more legible and there may be inert comments left to explain program flow to both the original and any subsequent developer. In addition, in a scripting environment, as used for EEMeC, some of the code is processed server-side and some sent to the client (usually as HTML or XML). It has also been identified that object orientated and 4th generation languages (which the EEMeC programming environment falls into) commonly depend on external objects and components, and as such LOC may be a misleading metrical quantity (Fenton and Pfleeger, 1997, p254).

Because EEMeC scripts are mostly linear and have little algorithmic structural complexity, few if any of the other metrical analyses of efficiency are relevant or meaningful. The following metrics are presented to provide a basic modelling structure for looking at EEMeC code:

- Total lines of code (LOC)
- Commented lines of code (CLOC)
- Blank lines of code (BLOC)
- Reused lines of code (RLOC) – these are the number of lines of code that are substituted in as part of include files and other external references.
- Database external calls (DEC) – these are the most common external object calls and will involve the establishment of one or more database connections and then one or more exchange between the database and the application per connection. This will be expressed as (connections | exchanges).
- Client-Side Code (CSC) – this is the code that is static text to be sent for execution on the client browser. Note that CSC can ignore the line breaks required for application logic (except for JavaScript).

The results of this analysis are shown in table 4.3.

Script	LOC	CLOC	BLOC	RLOC	DEC	CSC	LOAC
Index.asp	166	2	2	1|27	0|0	135	54
Logpass.asp	300	51	79	0|0	1|6	0	170
Myeemec.asp	1446	222	390	4|51	1|25	153	735
Node.asp	453	58	52	5|59	1|4	9	388
Threads.asp	285	6	43	2|32	1|2	142	124

Table 4.3: code size metrics for key EEMeC scripts. LOC = lines of code, CLOC = commented lines of code, BLOC = blank lines of code, RLOC = reused lines of code, DEC = database calls, CSC = client-side code, LOAC = lines of actual code.

From these basic measure the following can be generated:

- Lines of application code (LOAC) – this is the sum of the active program code for the main and all external components. LOAC = (LOC – (CLOC+BLOC+CSC+RLOC)) + ΣLOAC for all external code.
- Application code density (ACD) – this is the ratio between LOAC and the total LOC and represents the proportion of a script actively parsed on execution.
- Comment density is the ratio between comment code and actual code and has been identified as a rough approximation of a script's complexity (Fenton and Pfleeger, 1997) as more comments would indicate that they were required to explain more complex functionality.
- Client-side/server-side ratio is the ratio of a script that runs client-side to that which runs server-side. This is an additional measure to those in the literature and is required where there is the devolvement of some of an apllication's functionality to a client machine.

Calculations for these factors are shown in table 4.4.

Script	LOAC	ACD	Comment density	Client-side/server-side ratio
Index.asp	54	0.33	0.04	2.41
Logpass.asp	170	0.57	0.30	0.00
Myeemec.asp	735	0.51	0.30	0.16
Node.asp	388	0.86	0.15	0.02
Threads.asp	124	0.44	0.05	1.09

Table 4.4: size metric statistics for key EEMeC scripts.

Although the LOAC and client/server ratios vary greatly, the ACDs (median = 51%) and comment densities (median = 15%) are fairly similar. There are therefore some similarities between scripts, but as aspects of an analysis what does this actually mean?

To perform this kind of analysis on a more meaningful and statistically sound basis it would need to cover much, if not all, of EEMeC and as the system consists of many hundreds of scripts this would be a significant undertaking. More importantly however are the issues of how code is generated and maintained and how it fits into the function of the application as a whole. EEMeC has been developed in a craft-like fashion, building and testing applications organically and iteratively over time and there has been little or no use of formal development methodologies. As such EEMeC has been developed or grown rather than engineered. A metrical approach to evaluation based on code size would only have real utility where alternatives were being checked for equivalence or an execution of a design was being checked back to its original design template. In a wider sense such approaches are relevant only to the designer or programmer and then only where they are working within a formalised development process.

4.3.3: Structure as Metric

A common technique for analysing an application's structure is to render it as a flowgraph. A flowgraph represents the nodes and paths of information flow through an application, forming an abstracted graphical representation somewhat similar to a UML activity diagram (although far less detailed). There are a number of complex mathematical analyses possible with such flowgraphs, none of which are ideal (Fenton and Pfleeger, 1997, pp290-295) and all of which are inherently focused on the internal properties of software and its development. One of the more common measures is the 'cyclomatic number' of an application defined as follows:

the cyclomatic number , v = (number of arcs) – (number of nodes) + 2

and is intended to be:

> *"a mathematical technique that will provide a quantitative basis for modularization … to identify software modules that will be difficult to test or maintain" (McCabe, 1976, p308)*

This is based on analysing the different paths and loops an application can go through and is intended to essentially be a measure of complexity. Flowgraphs and the resulting cyclomatic numbers for two key EEMeC scripts are shown in figures 4.8 and 4.9.

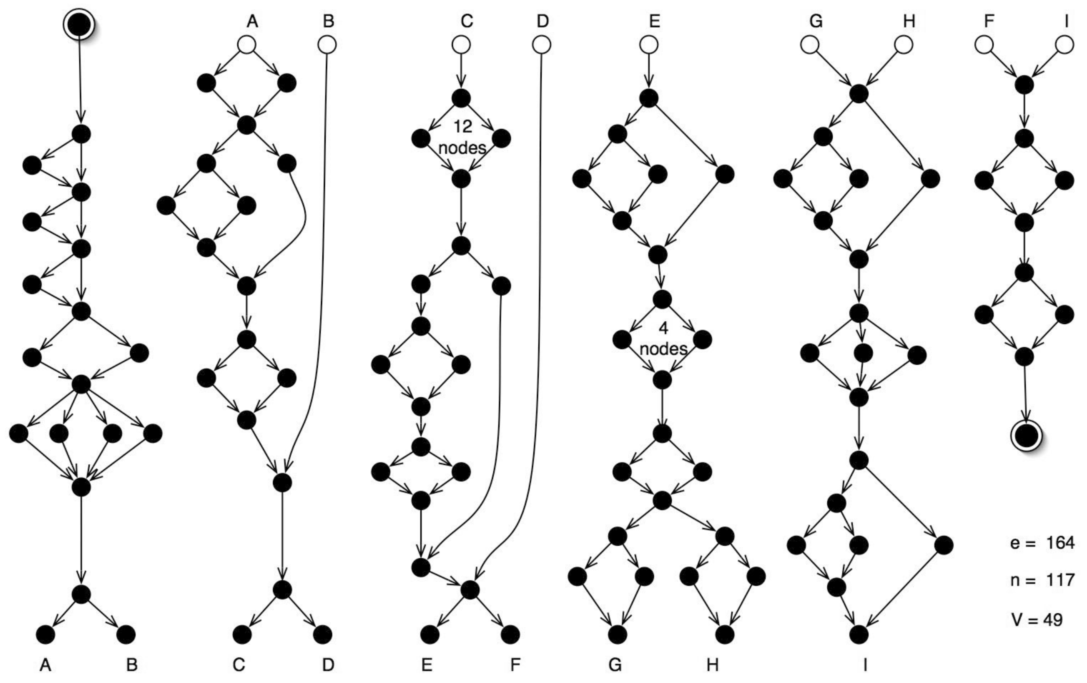

Figure 4.8: flowgraph for node.asp - the cyclomatic number is 49 (164 arcs – 117 nodes + 2). The diagram shows a single flow and is therefore broken into keyed segments. Letters at the bottom of each segment match with the letters at the top of later segments. Each node is a point at which the code can branch or rejoin.

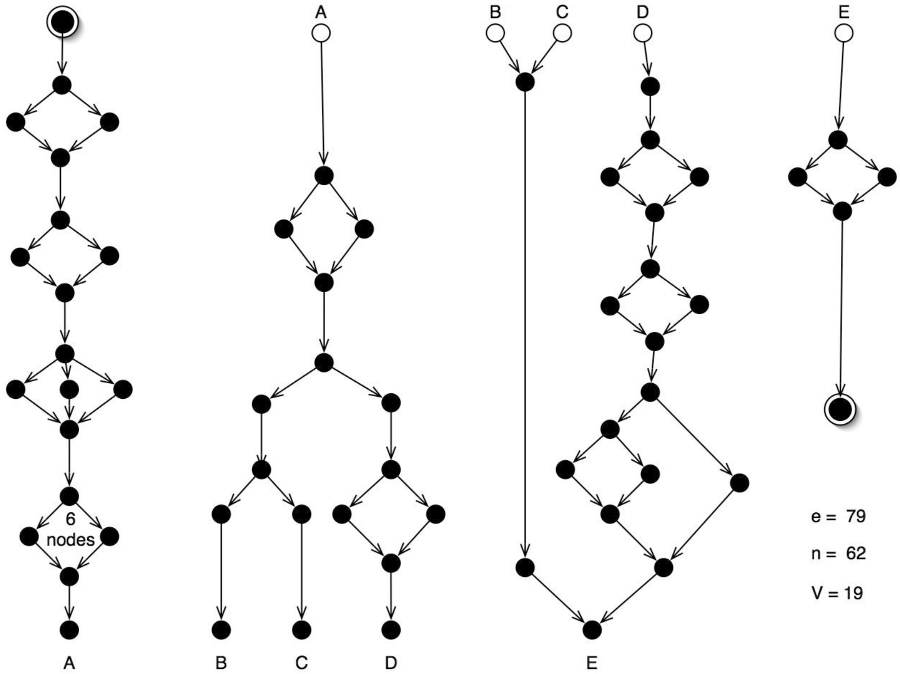

Figure 4.9: flowgraph for logpass.asp - the cyclomatic number is 19 (79 arcs – 62 nodes + 2). For details see legend of previous figure.

As a scalable methodology flowgraphs share many of the same problems as UML. EEMeC is a system that contains many hundreds of scripts with a wide variety of different sizes and complexities. At one level, all of these scripts perform similar generic tasks (uploading and downloading information, streaming data from the database, checking system and client variables) but they do so in different combinations and with different targets and parameters. Flowgraphs are also limited in use beyond the immediate context of formalised software development, as they need a broader context to give them any concrete meaning.

4.3.4: Productivity as Metric

Productivity is generally measured as the amount of output per unit of effort put in to a system. As a software metric a common measure of productivity is lines of code per man/hour. However this is obviously a very crude measure, as it takes no notice of the different ways programs might be constructed and developed and fails to consider whether the code produced is of any quality. This is compounded for EEMeC by the fact that its developers are not and have never been involved in full-time programming. An EEMeC developer will undertake a range of tasks in widely varying quantities over time. These include content management and maintenance, programming and development, staff development and dissemination, and communication, liaison and administration. Furthermore, there are no dedicated individuals who only work on EEMeC. There are a large number of projects and activities underway at any one time and a developer may have a role in many of them at any one time.

However at a very crude level EEMeC is the core application the team has developed over the last five years and as such an approximation of the amount of time spent (and therefore the cost of development) can be estimated as shown in table 4.4.

Year	*Hours spent*	*Total salary cost*	*Other cost*	*Total cost*	*Cost per man/hour*
1999-2000	1890	£45,000	£10,000	£55,000	£29.10
2000-2001	3150	£67,000	£3,000	£70,000	£22.20
2001-2002	3780	£84,000	£1,000	£85,000	£22.48
2002-2003	3780	£87,000	£3,000	£90,000	£23.81
2003-2004	3780	£92,000	£8,000	£100,000	£26.45

Table 4.4: estimated development costings for EEMeC between 1999 and 2004. A man/hour is based on an effective 30 hour week in a 42 week year = 1,260 hours per year per FTE.

The upfront cost for developing and managing EEMeC over the first five years of its existence has been around £400,000. The number of students supported per academic session permits a ratio of cost per student to be calculated as shown in table 4.5.

Year	*Total cost per academic session*	*Num students*	*Cost per student per academic session*
1999-2000	£55,000	440	£125
2000-2001	£70,000	660	£106
2001-2002	£85,000	880	£97
2002-2003	£90,000	1300	£69
2003-2004	£100,000	1300	£77

Table 4.5: EEMeC development costs per student per academic session.

4.3.5: Software Metrics as a VLE Evaluation Methodology

There are a number of analyses based on ‘software metrics’ for evaluating a computer system, only some of which have been reviewed here. However, a number of issues are common to all such approaches:

- Software metrical analysis of a VLE is only possible with access to both a its code and the processes by which it is developed. Thus, a developer or a vendor of a system may undertake this kind of analysis whereas the purchasers of an off-the-shelf system could not. In many cases however, an off-the-shelf system may require development work in its working environment to connect it to other systems and this work would be open to metrical analysis.

- Development methodologies vary greatly across the VLE developer communities; commercial systems are developed by formal ranks of software engineers, open source products are co-developed by potentially very large numbers of disparate programmers while home-grown systems are peculiar to their local developer methodologies and contexts. Any metrical system that presupposes homogenous developmental approaches will be limited in its relevance to what is a very heterogeneous development community. Six different developer/programmers have worked on EEMeC over the years, each of whom has had their own idiosyncratic coding style. Although some common procedures and methods have been adopted there is still a large degree of individuality in the way code is assembled in EEMeC.
- The tension between internal and external application properties was raised in section 4.3.1. An analysis based on code size, complexity or some other internal metric is limited in what it can say about a system in isolation. There are many other technical factors (let alone the many other dimensions of VLEs reviewed in subsequent chapters) that can affect a VLE's performance:
    - *Server load*: even if a VLE is internally efficient, if there are a very large number of people using it or if it is on a server that runs many other applications, then the VLE will run more slowly and indeed may in extreme conditions not run at all. EEMeC runs on a server shared with a number of other web applications and web sites including two other VLEs. EEMeC tends to be the busiest system and its heavy use often decreases the speed and efficiency of these other co-located systems.
    - *Database load*: even if an application is internally efficient, if there are many calls to the database or if large queries are being executed by the database then the application will run more slowly. For instance key scripts in the EEMeC Assessment Engine create complex data grids built of many database transactions and therefore perceived as running slowly.
    - *Network dependency*: even if an application is internally efficient, if the server is connected to a slow network or it is sharing a network with other traffic then performance can be reduced. EEMeC currently sits on a gigabyte Ethernet spur connected to a particularly fast network segment of the LAN, but for the first two years of its operation EEMeC sat on a shared 1MB Ethernet spur with much slower response times.
    - *Client dependency*: even if an application is internally efficient, if a user is connecting from a slow client machine or is using a slow network connection (such as a dial-up modem) then from their perspective the application will appear to run slowly (as will all other web traffic).
    - *Hardware configuration*: even if an application is internally efficient, if it is sitting on a server with a relatively slow processor, a relatively low amount of RAM, full hard disks or any of a number of other hardware performance-dependent characteristics running below

optimum, then its performance will suffer. During its lifetime EEMeC has had its main server replaced and then enhanced with more RAM and disk space, and it has been extended from all running on the one server to run on two application servers and a database server. These steps were undertaken mostly in response to the deleterious effect of the rapidly increasing EEMeC traffic upon the services delivered.

- *Language and platform specificity*: even if an application is internally efficient, the choice of operating system, development environment and database software will have an effect on the application's performance. EEMeC uses active server pages (ASP), a Visual Basic based scripting system running on Windows. Although ASP may not be quite as fast as languages such as C++ or Java, it is much easier to develop and maintain than most other languages. The database server is Microsoft SQL Server, which is able to manage very large amounts data and traffic with ease.

It is clear therefore that the internal aspects of a system have proved to be hard to quantify meaningfully using software metrics without recourse to the external attributes of the system. Furthermore, with a crafted and process-oriented development like EEMeC, using metrics based around formal methods and procedures has been shown to be limited for evaluation purposes.

4.4: Web Server Log File Analysis

A third way of looking at a machine is to observe it in action, looking at its syntactic inputs and outputs in a real context of use. For a VLE (and for any web application) the analysis of its web server log files can provide such data. Web server logs are recorded by the web server application of the transactions that it has handled. Logs are therefore an abstract record of the quantity of traffic for a web site or web application (such as a VLE), which can be processed to generate statistical views of system use over time. Web server logs can therefore provide a means for analyzing the syntactic aspects of the interactions between web client and web server and thus, between the user and the system. There are a number of ways in which transactions can be recorded:

- *'Hits'* records the absolute number of items requested. A web page may for instance include images, stylesheets and external script components. HTML works by referencing each of these items externally rather than embedding them within the page. When a page is requested from the server each component served is recorded in the log as a discrete request. Thus there may be many hits per page request.
- *'Pages'* records specific items, usually anything minus known data types such as images, multimedia files, documents or code components. This evidently gives a smaller number of returns but 'page' is equivalent to a user getting a webpage returned to them and is therefore a more direct measure of client/user activity than 'hits'.

- *'Bandwidth'* measures the amount of data transmitted (in bytes) and can differ significantly from 'pages' or 'hits' if there are different patterns in users requesting larger or smaller files. Although this is useful for network planning there is less equivalence to the user experience than 'pages'

The Internet Protocol number (IP) is a unique address for every machine connected to the Internet. The IP number of the client machine making the request to the server is recorded in the log file for each transaction. There are limits to the detail the IP number can represent has a limited ability to represent known individuals or groups of users:

- Within any large organisational computing environment there are often web caching servers where pages are held locally to reduce external traffic. The caching server may often be the one identified in the logs rather than the client that is requesting the file from the cache. A firewall may also have the same effect. Some pages and their components may be cached on the client machine and not therefore requested from the server.
- A dial-up service or a DHCP network will dynamically allocate an IP address for the duration of a computing or web session, and re-acquire it at the end of the session and dynamically issue a different one next time the user connects. In these situations there is no persistent IP number and therefore no mapping between a specific address and a specific individual's computer.

4.4.1: EEMeC web log file Analysis

Each line in a log file records the client's IP number, the date and time of the request, the type of request, the file requested, the protocol used and codes to indicate the result of the request. There is a separate line for each transaction and the EEMeC servers have been configured to record a new file for each day of operation. Log files for a busy system like EEMeC can therefore be very large. Although direct reading of server logs is possible, it is necessary to perform automated data analysis to manage server logs on any practical scale. For the log analysis for EEMeC a commercial web-based analysis tool called Sawmill (www.flowerfire.com) was used, which batch processes log files and then generates statistical reports on the data or subfilters of the data (such as for certain months or days). Log files for EEMeC have been kept continuously since March 2000, when the system was moved from its temporary UNIX/Apache server to its permanent Windows/IIS platform. The unit of measure is the 'page' view, which includes plain html text pages, asp (active server pages) server-side scripted text pages and binary PDF files.

4.4.2: EEMeC Longitudinal Traffic 2000-2003

A longitudinal plot of page views per month shows how traffic changes over time (see figure 4.10).

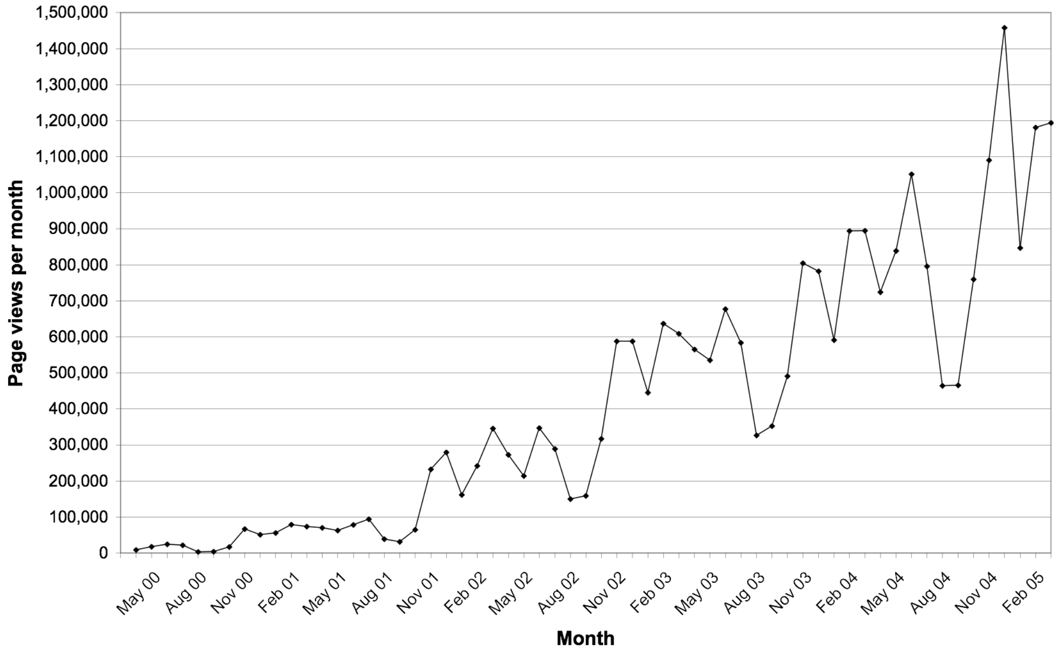

Figure 4.10: Page views per month for EEMeC between March 2000 and December 2004. Traffic has grown over time with the growth gradually accelerating. The periodicity of the three terms is clearly seen in the three academic years 2001-2, 2002-3 and 2003-4.

Although it is clear that EEMeC traffic has increased over time, there are other factors that need to be factored in. EEMeC was developed in support of the new Edinburgh MBChB curriculum that started in the 1998-1999 academic session for year 1 and was progressively rolled-out, a year at a time, so that the five year course completed in the 2002-3 academic session. EEMeC was launched for the 1999-2000 academic session, initially covering years 1 and 2. In each academic session, as a new year was added to the new curriculum, a year was added to EEMeC. This meant that on average 230 students per academic year, and their supporting teachers and support staff, were added to the EEMeC user community in each session up to 2002-3 when, as the full MBChB was then being supported by EEMeC, the number of potential users stabilized. The increase in EEMeC traffic should therefore be tempered by factoring in the changing number of potential users of the system (see figure 4.11).

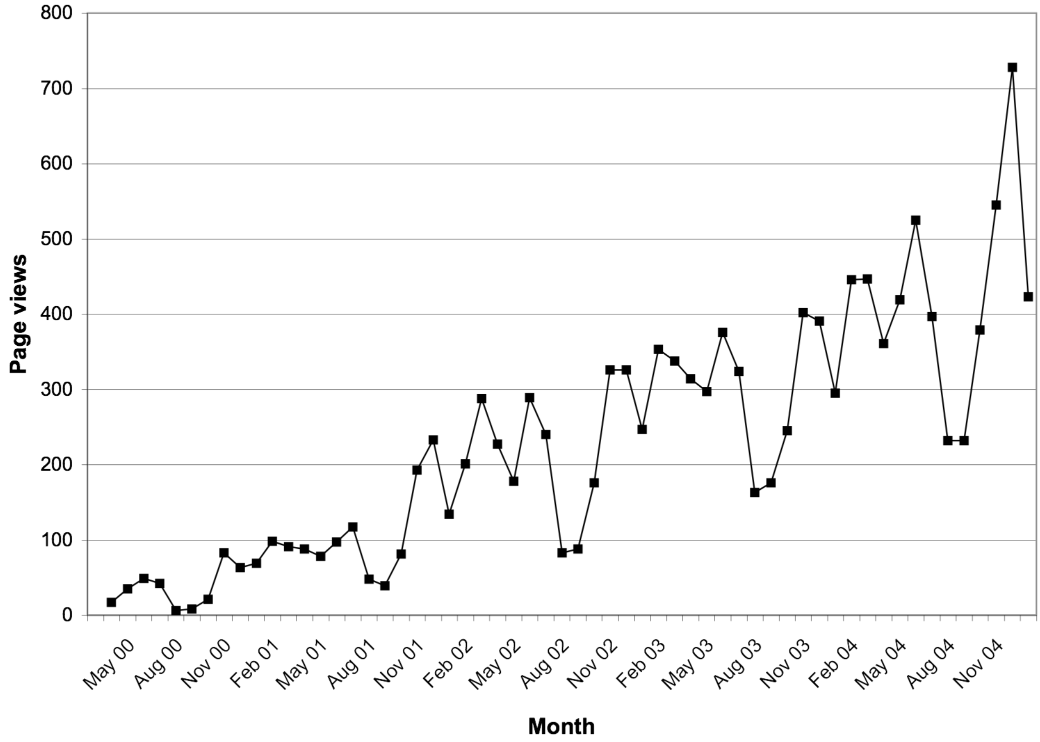

Figure 4.11: EEMeC traffic between March 2000 and December 2004, measured in page views per potential user.

The user-compensated plot still shows a steady increase in EEMeC activity per user although this is more linear than initially indicated in figure 4.10. The distinction between a blunt indicator of activity such as page views and a qualified indicator such as page view per potential user is therefore an important one, although it is only possible with a discrete user community where the potential user base is quantifiable; for a closed course VLE this should always be possible.

4.4.2.1: Internal and external traffic

The network location of EEMeC's users is an important issue when planning infrastructural and architectural aspects of the system. This can be derived from the client's IP number. IP numbers have a hierarchical structure that allows for useful groupings and sets of numbers to be handled as a single set. An IP number consists of four numbers between 0 and 254 separated by full stops. Each number represents a hierarchical domain; each number from the left is a subdomain of the one before it. Thus, for EEMeC, 62 is a subdomain of 82 which is a sub domain of 215 which in turn is a subdomain of 129. Whole domains of IP numbers are allocated to various organizations. EEMeC's IP number is, as part of the University of Edinburgh, within the 129.215 domain, 82 is a subnet on the Edinburgh domain and 62 is a unique machine number within the 82 subnet. All traffic from the University of Edinburgh has an IP address that starts with 129.215. Filtering log files to show those IP requests from the Edinburgh domain, and thus, by subtracting this quantity from the overall number of requests, to show the requests from outside the Edinburgh domain provides a view on the balance of activity emanating from within the University and from beyond (see figure 4.12).

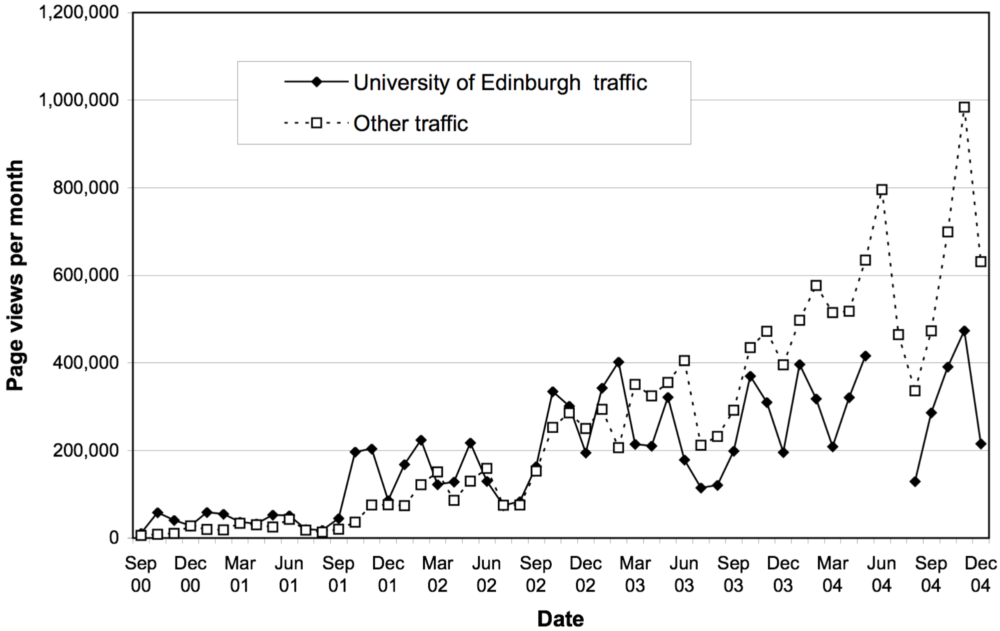

Figure 4.12: EEMeC traffic measured in page views per month for University of Edinburgh traffic and traffic from all other domains between March 2000 and December 2004. This shows that traffic originating from with the University of Edinburgh was the larger component up until around March 2003 when the external traffic component overtook it. There are several reasons for this. Firstly, years 3, 4 and 5 are largely located in the large teaching hospitals and district general hospitals and clinics throughout South East Scotland. Any traffic originating from these organisations will be shown as external traffic. Secondly, personal ownership of computers has increased markedly (see figure 8.1), leading to an increase in the number of individuals accessing systems like EEMeC from home.

4.4.3: EEMeC Weekly Traffic

Traffic per day of the week is shown for EEMeC in Figure 4.13, and demonstrates significant levels of use of EEMeC on Saturdays and Sundays despite there being no scheduled course activity on those days. This demonstrates that EEMeC can and does extend user's engagement with the course beyond scheduled contact time. Although students studying in their own time is not new, the form of the study and the forms of engagement with the course are potentially new as a result of the VLE. Certainly this kind of view on student activity has not previously been available without concerted research activity.

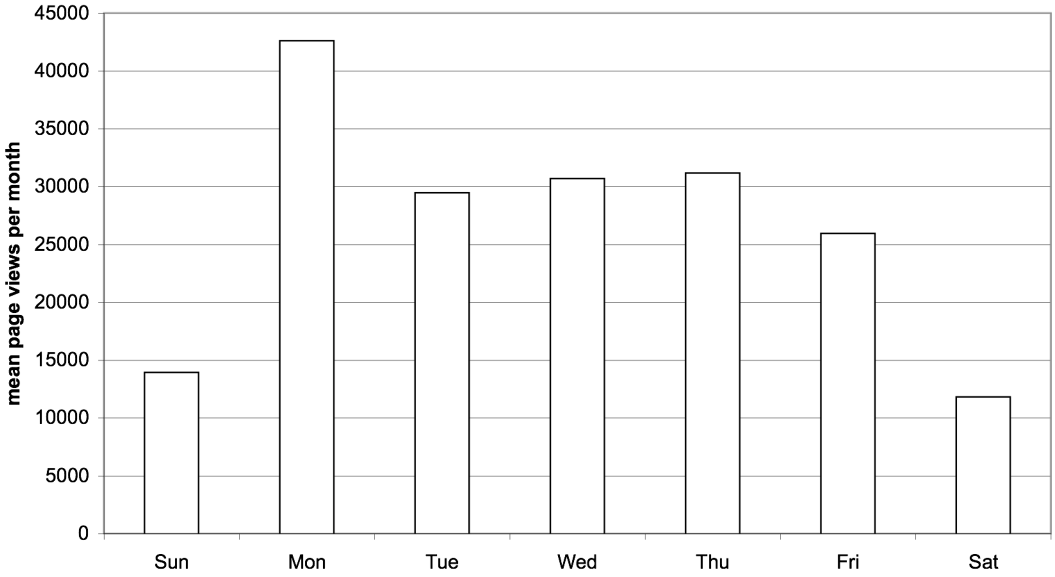

Figure 4.13: Average page views per month per day of the week for EEMeC between March 2000 and December 2004. This shows a significant peak on Mondays, a slight fall off in use over the week with around half the level of weekday access on Saturdays and Sundays.

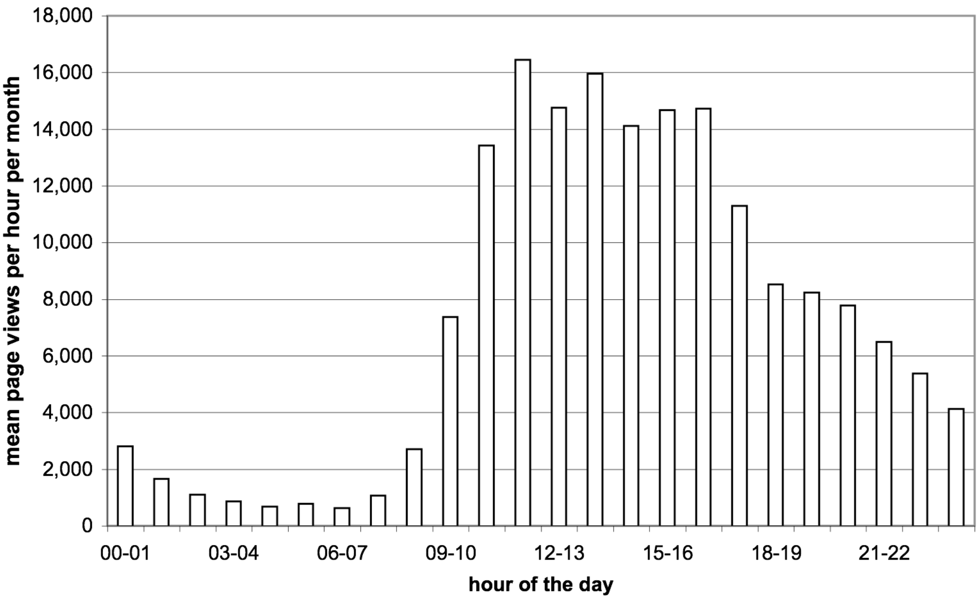

Figure 4.14: Average page views per month across a 24-hour day for EEMeC between March 2000 and November 2003. The graph shows a fairly normal bell-curve distribution of access over a 24-hour period with the lowest point between 3am and 5am. There is a steep increase in traffic after 8am and peaking at 11am. This is followed by a fairly level of use between 11am and 5pm with a peak at the 1pm to 2pm lunch hour and then a steady but slow decrease in activity during the evening that eventually finishes around 2am. The lack of early morning activity and the extended evening activity can be seen to mirror the student working day while the significant 9am to 6am plateau includes both staff and student activity.

4.4.4: EEMeC Daily Traffic

In a similar approach to that taken for days of the week, the patterns of use over a 24-hour day can also be analysed as shown for EEMeC in Figure 4.14. As was shown in the weekdays plots, EEMeC is demonstrably helping students and staff to remain in contact with the MBChB out of working hours.

4.4.5: Top Pages and Directories

This is a ranking of the most often requested pages or directories. This can show the most popular areas or functions within a site. Table 4.6 shows the top pages and directories for EEMeC between December 2002 and November 2003. Although these are just rankings, the dominance of discussion activities, the centrality of My EEMeC and the use of the content management system are all useful evaluative pointers to how the system is being used. What this information does not indicate however is the quality of use or the nature of the user experience.

	1st	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*
Dec 02	disc	myeemec	disc	index	logpass	node	notices
Jan 03	disc	myeemec	disc	index	node	logpass	notices
Feb 03	disc	disc	myeemec	node	index	logpass	notices
Mar 03	disc	disc	myeemec	node	index	logpass	notices
Apr 03	disc	myeemec	disc	index	logpass	node	notices
May 03	disc	disc	myeemec	node	index	logpass	notices
Jun 03	disc	myeemec	disc	node	index	logpass	notices
Jul 03	disc	disc	myeemec	node	index	logpass	notices
Aug 03	SW	disc	myeemec	node	index	logpass	notices
Sep 03	disc	SW	node	myeemec	index	logpass	notices
Oct 03	disc	node	myeemec	disc	index	logpass	notices
Nov 03	disc	myeemec	disc	node	index	logpass	notices

Table 4.6: A ranking of the top pages and directories for EEMeC between December 2002 and November 2003. Disc=discussion, SW= student webs, 'My EEMeC' is the effective homepage. Discussion boards have been the most used area of EEMeC followed by "My EEMeC", the personalized, page that displays notices and links to user specific tools and resources, and then "Node", EEMeC's content management page. "index" and "logpass" are the login points to EEMeC and are the fourth most used. The prominence of these items indicate that many logins may be solely to join in discussions or to check information on the user's 'My EEMeC" pages. The EEMeC noticeboard, the principle means of communication between tutors and administrators on the Edinburgh MBChB, is the fifth most used.

4.4.6 Unused EEMeC log data analyses

There are other forms of analysis data that have not been used:

- Session length: the length of time each user stays connected to the server as the period of time for a distinct IP from its first to last page request within a 60 minute period. An EEMeC session does not usually involve continuous online work but is interleaved with other activities. It is therefore limited in its representativeness of user activity.
- Entrance and exit pages: the first and last pages accessed per user session. All users need to authenticate to EEMeC so the first page is known.
- Worms: viruses and other attacks on the server.
- Filetypes: the range of file types accessed. The log analysis disregards images, stylesheets and multimedia files. All other items are of interest as page views.
- Authenticated users: EEMeC is set up to use the IIS anonymous user account so there is only ever one authenticated user registered on the server logs. Individualisation of logins is at the VLE application/database layer and will be discussed in the following section.

4.4.7: Web server logs – strengths and weaknesses

The log files represent the traffic that the web server has actually dealt with. A fundamental problem with using server logs is that web technology uses caching mechanisms at every level to improve speed and efficiency. This caching occurs when copies of a server's pages are held on the user's own computer or on some intermediate system, for instance for an organisation like a university, an Internet service provider (ISP) or even a country or region. In these circumstances if the user is routed via the cache then the cache copy of that page may be served rather than it being obtained directly from the server, and thereby not registering as a logged request (Goldberg, 1995). However, web applications, such as VLEs, combine server-side logic with content. These dynamic pages must always be run from the server and are therefore always logged there. For EEMeC, because the number of static items is small (such as plain html pages) or disregarded (such as images), the log files and their subsequent analyses can be considered to be a reliable account. Assuming that a VLE's server has been functioning properly, the log files represent a particularly objective record of the HTTP requests made to that server. By looking at the patterns of access for a specific site or system (such as a VLE) a good degree of information can be derived about the quantity of use and its periodicity.

Log data is highly abstracted and can therefore be analysed in a wide range of ways. Its interpretation however relies on a good knowledge of the site or system in question and a good level of technical expertise in Internet technologies. Furthermore the parsing of the very large amounts of raw data that a set of server logs can contain will often require specialist tools to at least generate intermediate sets of aggregated data that can be plotted or further cross-analysed, as was the case with the EEMeC logs.

Because the logs can only be syntactic, in that they simply record traffic, the analysis of log files offers little or no semantic or qualitative measures of how things are being used or why, just what is being used and when. Furthermore they offer no measure of what the user actually does when the information or tools are served to them, and in that way this approach remains inherently mechanistic.

4.5: VLE Application Log File Analysis

VLEs can also keep log files. These are specific to the system and as such are often less standardized and more specific to that particular system. Potentially any event such as a user or system activity, function or transaction can be logged. Logging large amounts of user data can be both time and memory consuming for the server and may also be unacceptable to the users community or raise legal issues. The other main difference between web and VLE logs is that the latter can be correlated with semantic signifiers from elsewhere in the system. For instance, a user's ID can be correlated with what kind of user they are, e.g. whether they are a teacher or a student. This correlation adds dimensions of identity and discrimination not available in anonymous web server logs.

There are ethical issues and constraints surrounding the logging of user information in a system such as a VLE. For instance legislative frameworks such as the UK's Data Protection Act provide rules for how personal data can be held and processed. An institution or course may also have its own rules and regulations regarding the use of such data. User tracking will be covered in chapter 10.

4.5.1: EEMeC Log files

EEMeC has been developed constantly since it began. Its first iteration, starting in October 1999, ran on a Unix sever as a simple website with no security at all. In March 2000 it was moved to a Windows 2000 server and basic authentication instantiated. In July 2001 the Access database was upgraded to MS SQL Server and all logins to EEMeC began to be recorded. The data therefore starts in July 2001.

In the period of analysis (July 2001 to December 2003) there were 695,989 successful logins to EEMeC recorded in the LOGINS table. A join between the LOGINS table and the USERS table was needed to record each user's principal usertype as well as their user ID. The usertypes are years 1-5, staff, 'intercalated' (students who take a one-year BSc degree after year 2) and 'other'. Because student cohorts change from year to year (some students intercalate, some resit years and so on), the archived session versions of the EEMeC database were used for the appropriate merge; EEMeC2001 for July 2001-June 2002, EEMeC2002 for July 2002-June 2003 and the current live EEMeC database for July 2003 – December 2003.

Data was extracted as a series of CSV files, joining the LOGINS table with the appropriate session version of the EEMeC database. The CSV spreadsheets were then analysed using MS Excel and MS

Word to count logins for different groups and IP matches within groups, and used to generate graphical representations of the LOGINS data (see figures 4.15a-c).

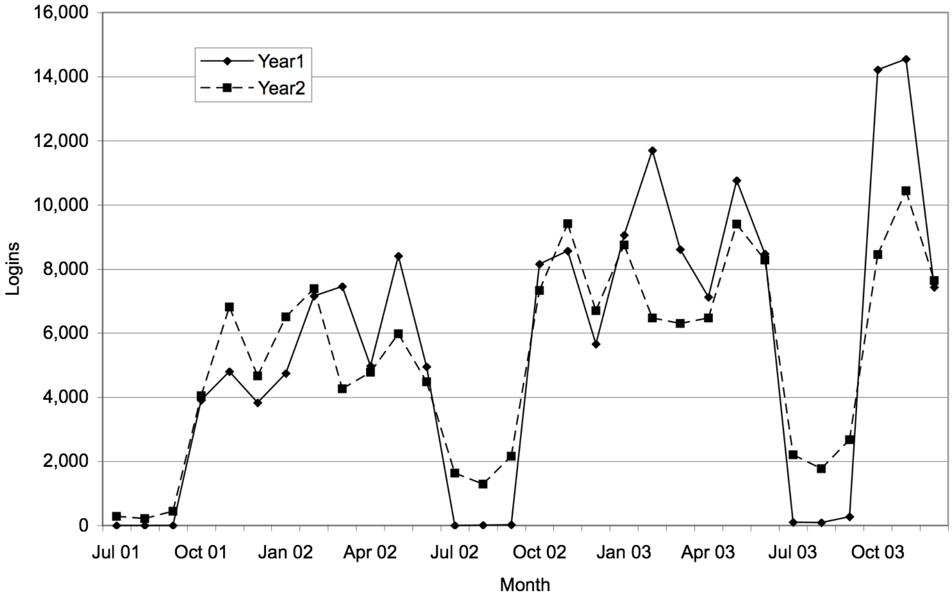

Figure 4.15a: EEMeC logins per month for years 1 and 2 between July 2001 and December 2003. This shows a clear periodicity based on terms and the summer vacation. Note that students moving from year 1 to year 2 continue to use EEMeC over the summer vacation.

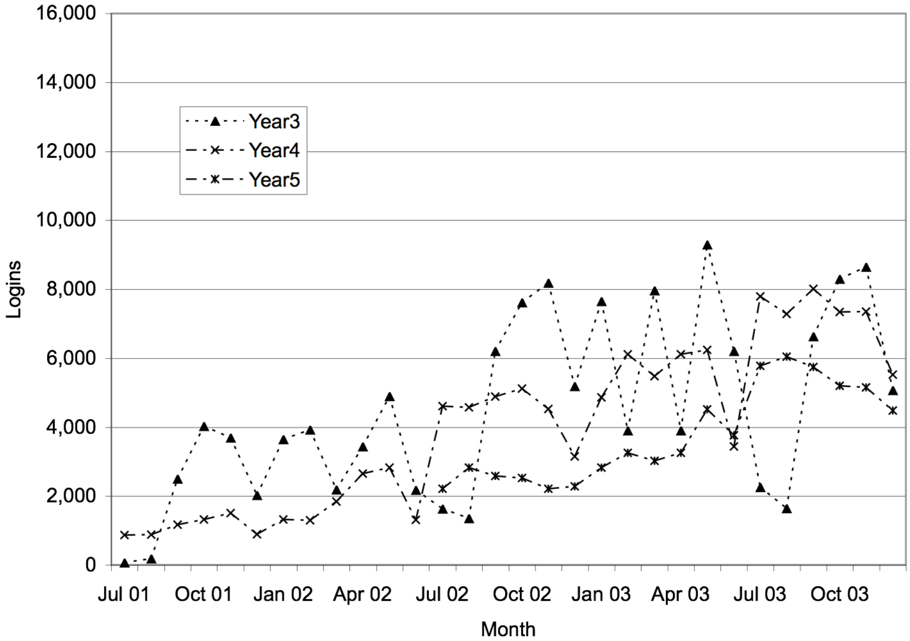

Figure 4.15b: EEMeC logins per month for years 3, 4 and 5 between July 2001 and December 2003. This shows lower activity than for years 1 and 2 but less variation or periodicity over time. There is most marked variation for year 3 while years 4 and 5 show a gradual but less variable increase in use.

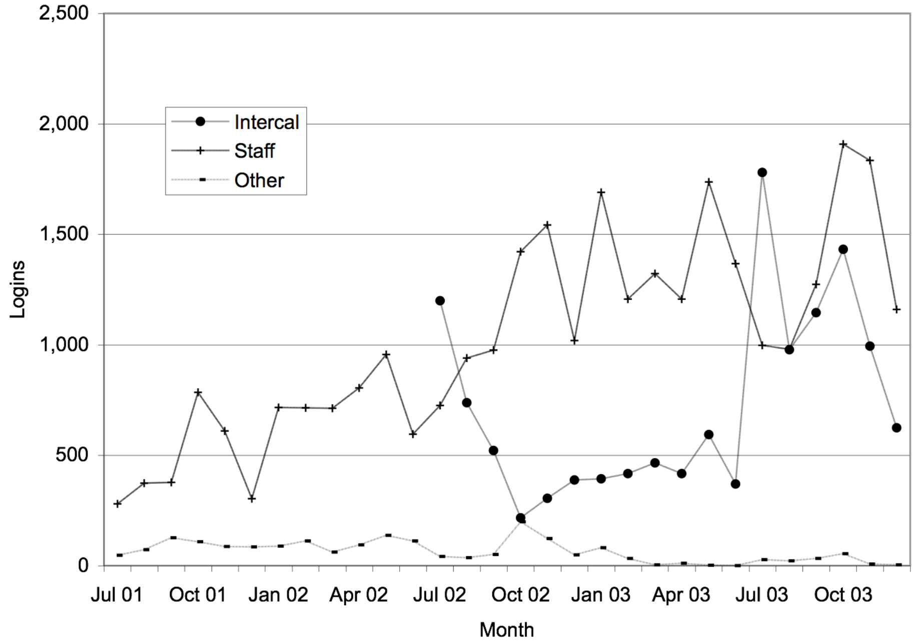

Figure 4.15c: EEMeC logins per month for staff, intercalated students and unassigned student users between July 2001 and December 2003. Note the difference in vertical scale from figures a and b which indicates the lower level of traffic from these groups. Staff use shows some term-based periodicity along with steady growth. Intercalated students show peaks toward the end of their year as they prepare to rejoin the MBChB and the unassigned student use is reduced over time as unassigned status is removed from the system.

4.5.1.4: Logins from within and from beyond the University network

As discussed in the section on web log analysis, the client machine accessing EEMeC identifies itself by way of a unique IP number. The University of Edinburgh network is made up entirely of IP numbers in the 129.215.x.x domain, where x is any number between 0 and 254. The IP number of every successful client connection to EEMeC is recorded in the LOGINS table. This allows the levels of connections to EEMeC from within the University network and from outside that network to be calculated. This particularly important for a number of reasons:

- Those planning, maintaining and resourcing student access to computing facilities need to know how well they are being used and what alternative levels and forms of access are also being used.
- Those designing VLE services when considering bandwidth, authentication, integration with third-party services need to know to what degree users outside the university network need to be accommodated. For instance, outside of medicine, many courses and university services restrict access to services and resources based on IP address under the expectation that all legitimate access can and will take place only on the university's network.
- Modes and patterns of student and staff activity, particularly in medicine where a significant part of the work of the course takes place outside the university (in hospitals and clinics across the

region), needs to be known when considering further provision of services and in the support of those users within the university network and beyond it.

The logins to EEMeC for each cohort from within the university network are shown in figure 4.16a and 4.16b while 4.16c shows traffic from outside the University network.

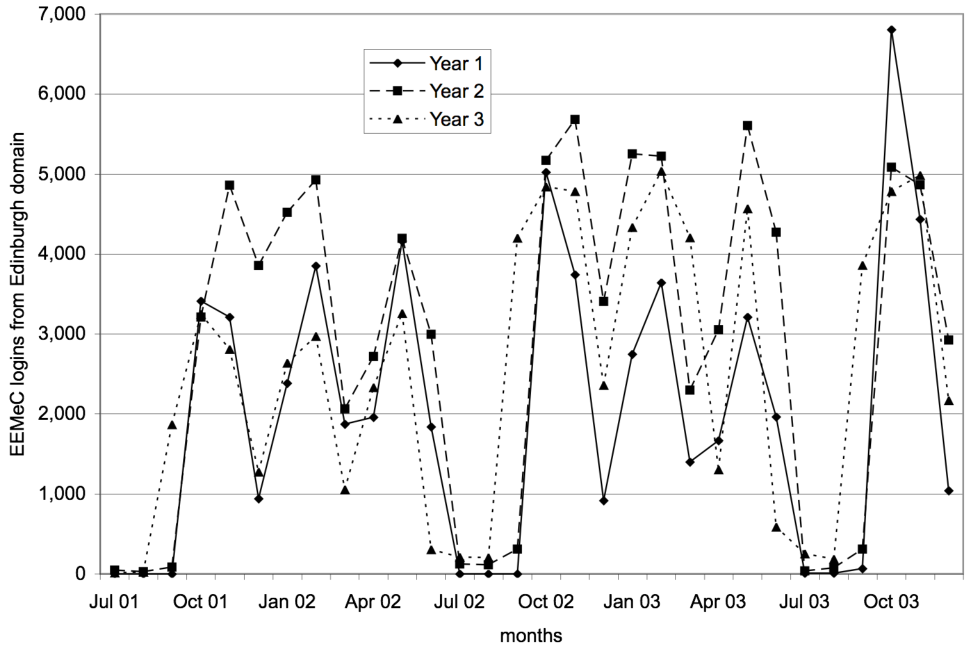

Figure 4.16a: logins to EEMeC from within the Edinburgh network for years 1-3. These show a term-based periodicity. Although this might be expected for years 1 and 2, year 3 does not follow a term pattern.

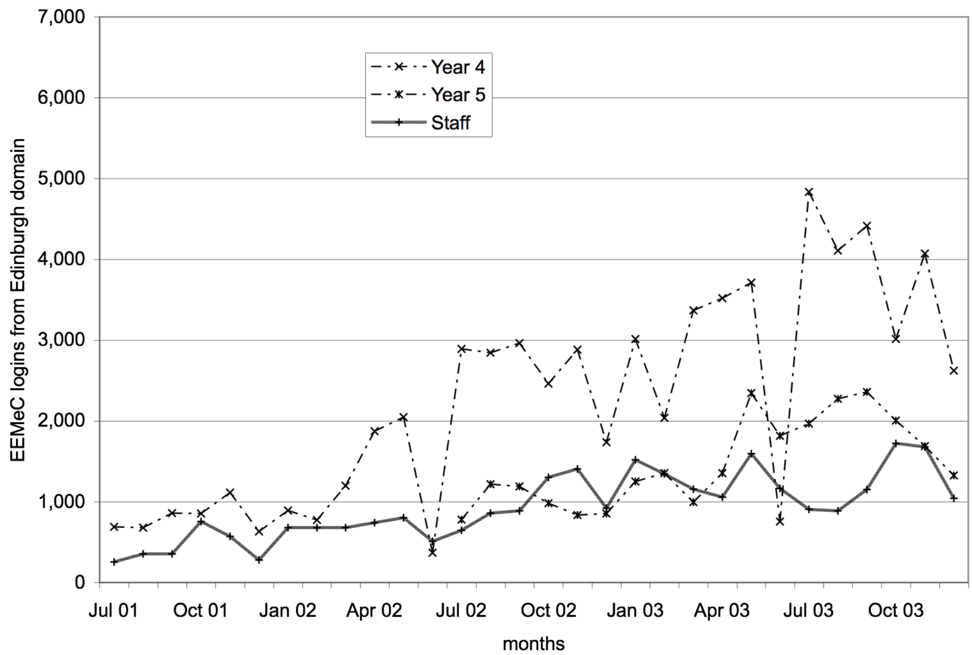

Figure 4.16b: logins to EEMeC from within the Edinburgh network for years 4-5 and staff. All cohorts show gradual growth with little periodicity. Year 4 has the greatest periodicity with clear dips over vacation times.

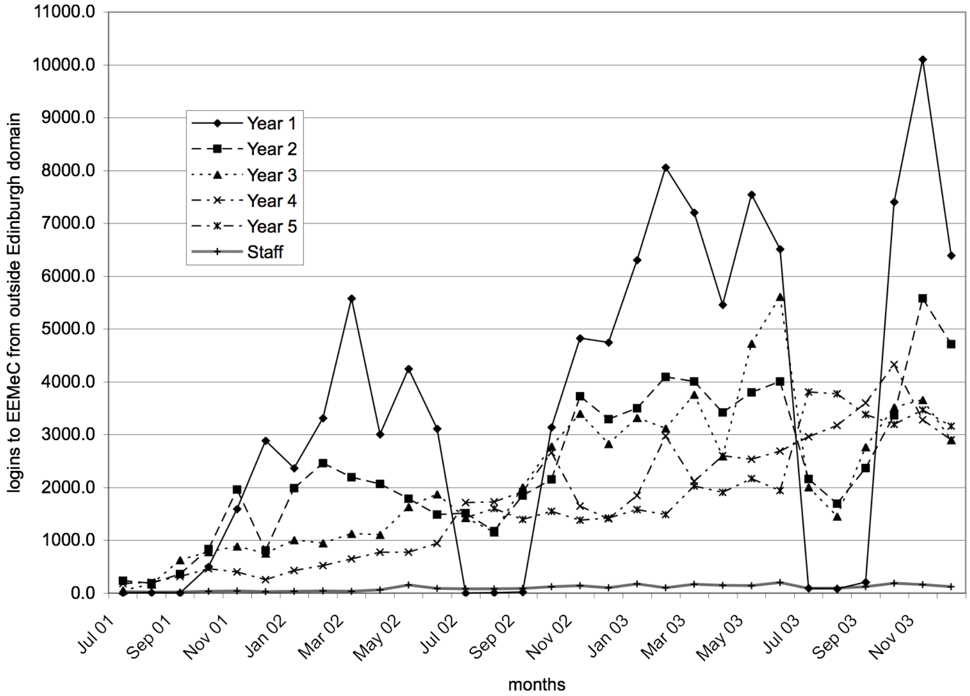

Figure 4.16c: logins to EEMeC from outside the Edinburgh network. Only year 1 shows strong periodicity. After year 1 students tend to access EEMeC from outside the University fairly consistently. Staff hardly ever access EEMeC from outside the University.

In order to analyse the relationship between the inside and outside access, student cohort logins were summed per month and plotted along with those for staff, see figures 4.17a and 4.17b.

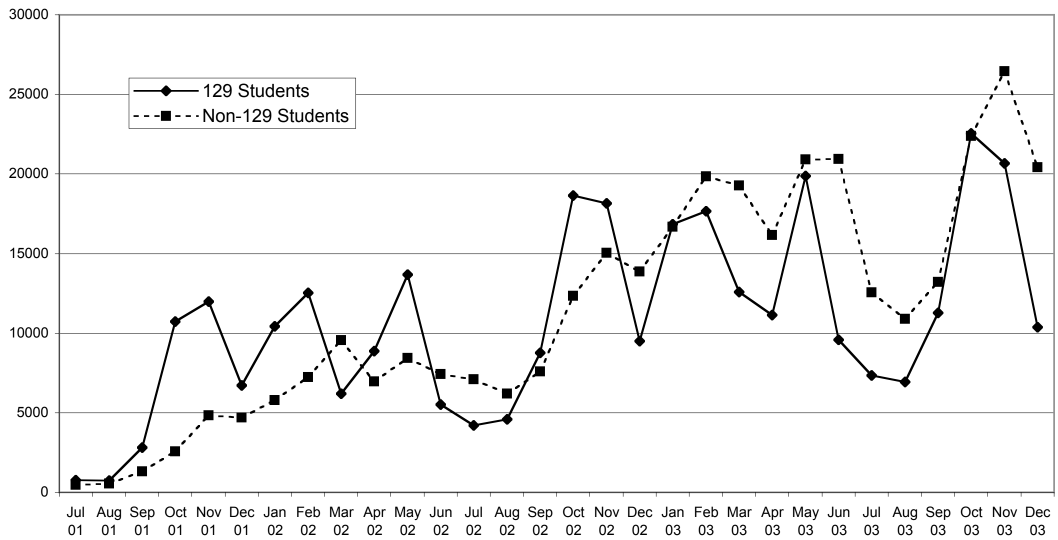

Figure 4.17a: student logins to EEMeC from Edinburgh domain network (129) and beyond the Edinburgh domain (non-129). The graph shows increasing levels of access for both internal and external traffic. The external access now exceeds that for internal access to EEMeC.

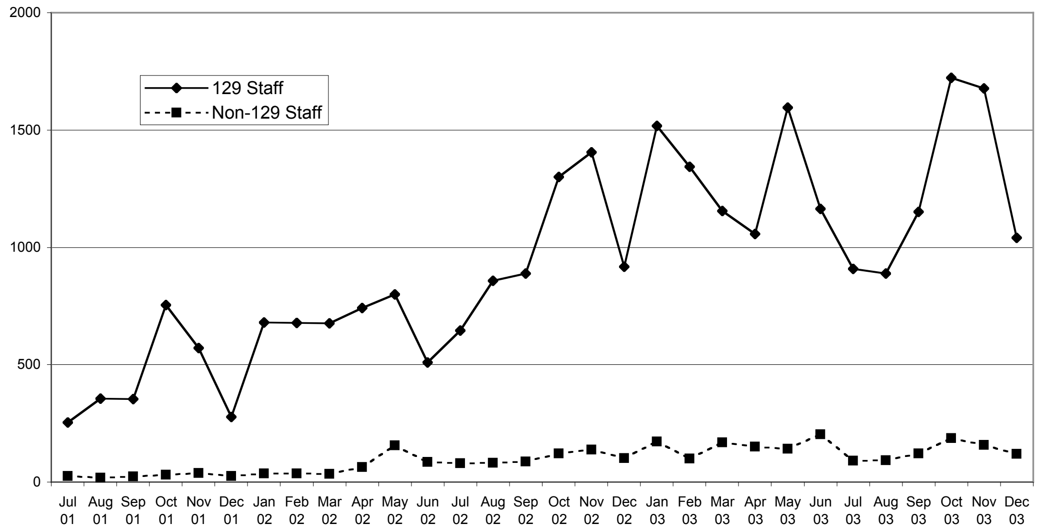

Figure 4.17b: staff logins logins to EEMeC from Edinburgh domain network (129) and beyond the Edinburgh domain (non-129). This graph shows far lower levels of external access than internal access for staff to EEMeC.

In order that the difference in internal and external login patterns for students and staff is more clearly seen the percentage of internal to external traffic for each group can be calculated and plotted (figure 4.18).

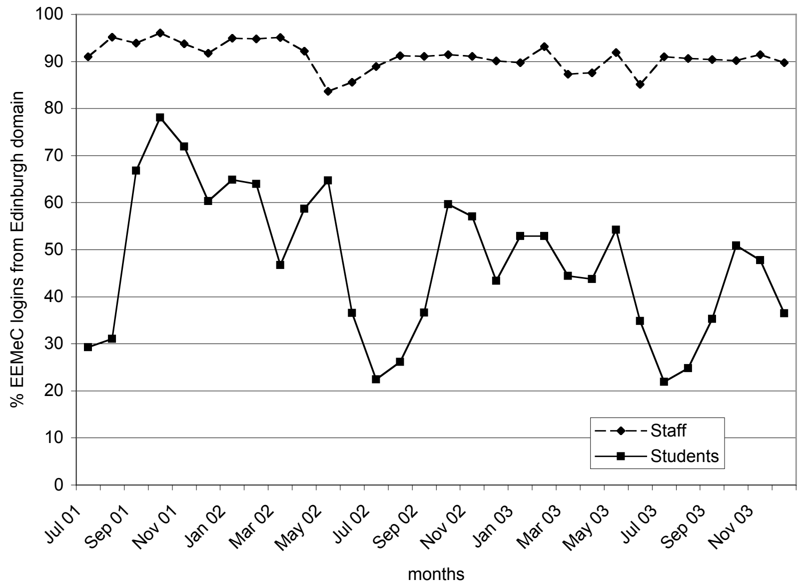

Figure 4.18: percentage of total logins from within Edinburgh domain for students and staff. The trend to more external traffic for staff is negligible. Students on the other hand show a marked proportional increase in external traffic of around 10% a year.

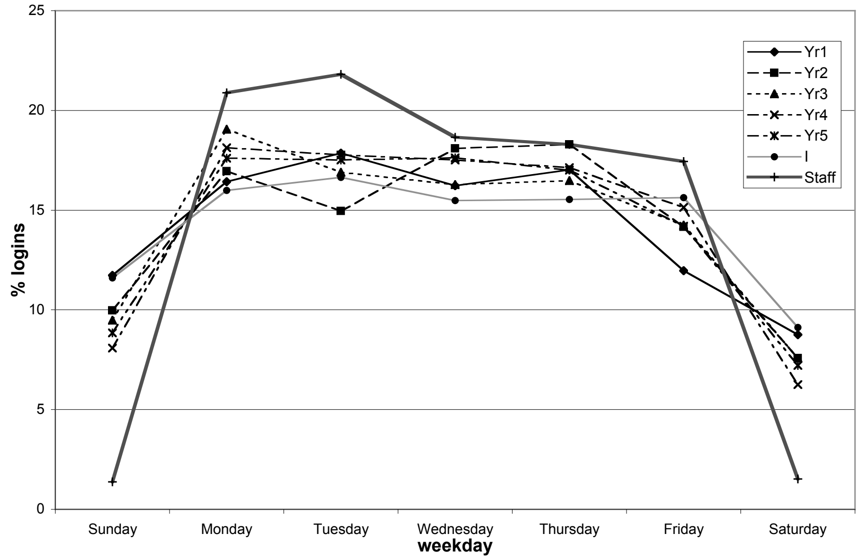

Fig 4.19: percentage logins per cohort to EEMeC to EEMeC by weekday between July and December 2003 inclusively. This shows a fairly even pattern of access across all student groups with around 20% of logins taking place on weekends. The staff cohort is notably different with only 4% of logins taking place on weekends and a peak of access on Mondays and Tuesdays. Comparing this with the page views over a 24-hour period (although for a wider sample) shown in figure 4.13 there is a high degree of congruence between the two.

4.5.1.6: Logins per weekday per cohort

The LOGINS table can also yield information on the periodicity of access across a 7-day week or a 24-hour day (see section 4.4.1.7). In order to get a stable sample, data for this analysis was taken solely for the 2003-4 session between July 2003 and December 2003. As the main focus is to observe the periodicity of access for each group, the percentage of total logins per cohort per day was taken and plotted in figure 4.19.

4.5.1.7 Logins per 24-hour period per cohort

As for logins per weekday in the last section, the sample was taken between July 2003 and December 2003. Again, as the cohort activity was not the same the data was re-plotted to show percentage of logins per hour per cohort. This is shown in figure 4.20.

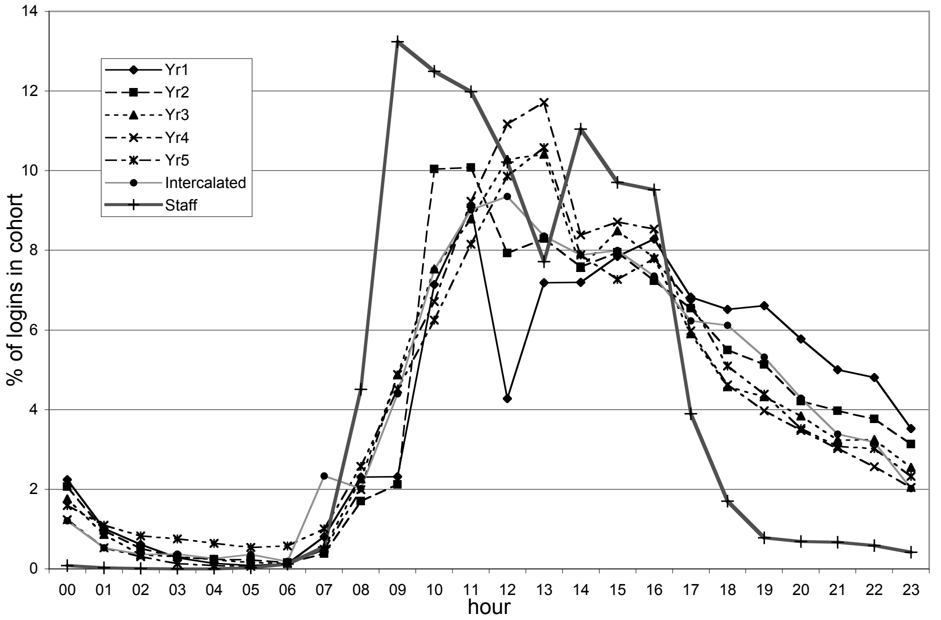

Fig 4.20: percentage pf logins per cohort to EEMeC by hour between July and December 2003. The staff cohort is as before the atypical case with the morning peak 1 to 2 hours before the student peak, a lunchtime trough, a quick roll-off after 4pm and relatively low levels of evening access. The lunchtime pattern reverses across the course. Year 1 takes a definite break at lunchtime; year 2 has a morning peak dropping at lunchtime to a plateau across the afternoon, and years 3, 4 and 5 all display lunchtime peaks. This indicates that students at the clinical end of the course tend to access EEMeC in breaks from scheduled clinical sessions whereas students at the start of the course have more time to access EEMeC during the day. The evening roll-off shows a decreasing proportion of access further up the course. Year 1 shows a higher proportion of evening logins that diminish for more senior years. Early years students appear to have a more distributed mode of working. This may be a result of the increasing pressures and time commitments required by later stages in the course. It should be noted that there is a constant level of background traffic generated by web search engines and their 'crawler', 'spider' or 'robot' programs as well as the hacker traffic, which has less beneficial ends in mind. This traffic can be likened to a kind of 'background noise'. The data from LOGINS show that there is a continuing, although low level, of user access throughout the night, meaning that 'server noise' is very low and can be disregarded. This analysis fits well with the data shown earlier in Figure 4.13 but with a more detailed level of qualification.

4.5.1.8 Frequency of Individual Logins

The frequency of individuals logging into EEMeC can also be analysed. Figure 4.21 shows the mean number of logins per user for different cohorts for the 2003-2004 academic session.

4.5.2: VLE logs – strengths and weaknesses

A VLE's log files could potentially be set to record any data about any discrete system event and more importantly correlated within the system to identify individual users and their membership of groups and cohorts. However, the logistical practicalities of doing this and the ethical constraints on what data can be recorded, and how it can be used, mean that VLE logs are unlikely to be fully comprehensive in practice. Another issue is that of ownership of the log data.

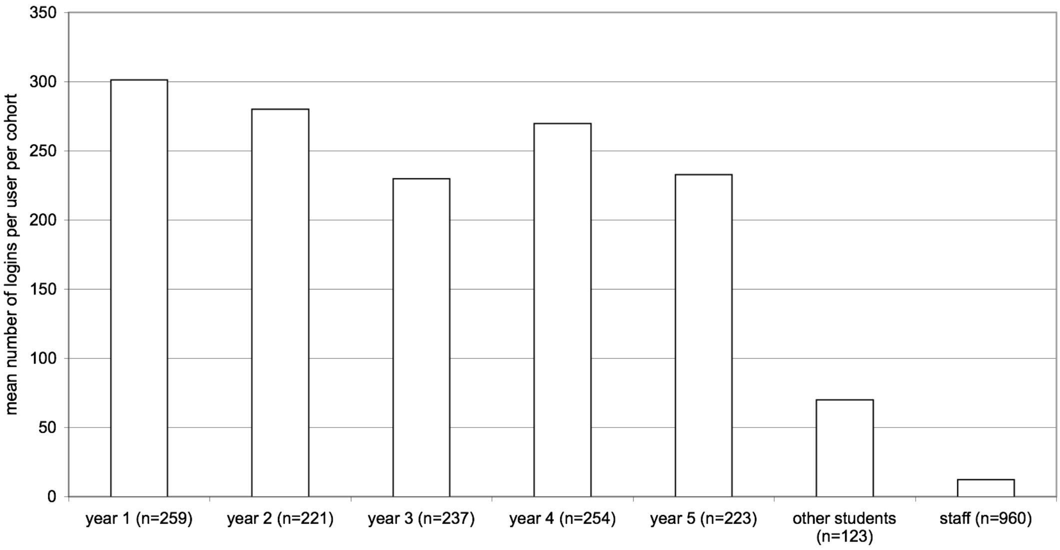

Fig 4.21: mean number of logins per user per cohort to EEMeC between July 2003 and June 2004. Students in years 1 to 5 show similar levels of use with a slight reduction in later years. Staff on the other hand show much lower levels of activity with 58.6% of this group having never logged in to EEMeC.

For WebCT at the University of Edinburgh for instance, the VLE log data is considered to be the property of the course organiser and currently no attempt is made centrally to analyse or use this information without each organiser's express consent.

The main benefits from the VLE logs are that they make inter-cohort analysis possible for the same kinds of global analyses derived from the web server logs. The forms of data and points at which it is recorded will determine the use of VLE logs in an evaluation context. From a practical perspective then, a VLE's log will have greater utility if the events they record can be activated or deactivated to fit in with specific contexts of use.

The strengths of this approach lie in the ability to capture specific events as the VLE is being used, which may not equate to an entry on the web server logs. Furthermore a greater amount of qualifying data can be captured with each event allowing for a more substantial analysis. The weaknesses lie in that not all data are recorded and there are inevitably constraints on the amount of personal data that it is permissible to record. It is also problematic that if these logs are not recorded in a standard web format (and thus limited to web log data models) then there are no existing tools available for analyzing these log files. In this case either the analysis will just take longer or tools will need to be developed within the VLE or external to it.

4.6: Checklists and Inventories

The most common approach to evaluating VLEs in the literature has been based on reckoning their features and functions using checklists and inventories. These provide a series of categories or criteria against which a VLE is checked or rated for the presence of a tool or function. A simple example of this would be: VLE 'A' has tools that support discursive activity while VLE 'B' does not. For a situation that values and requires the support of discursive activity it would be reasonable to expect that VLE 'A' is going to be a more appropriate system than VLE 'B'.

This kind of approach does not employ checklists or inventories in the formal research and evaluation sense (Oppenheim, 1996, pp241-250) in that do not employ controlled or scaled inputs. Instead, they most often take the form of semi-structured frameworks, where inputs are either binary (yes/no), a quantitative measure (3 of something), or a free-text response.

The selection of which criteria are important, how they are grouped together, and any associated scoring or weighting procedures, are all key issues in the suitability and efficacy of these instruments. Few provide justifications or derivations of their structures; most are provided as-is and lead the evaluator to accept the instrument without further amendments. A selection of VLE checklist evaluation frameworks for VLEs is shown in appendix 4.1.

4.6.1: Using a Checklist Evaluation

In order to better evaluate the checklist approach, four of the frameworks were used to evaluate EEMeC. They were selected as covering the different kinds of checklist approaches taken in the sample.

- EduTools Framework: the EduTools framework was selected as it represents a basic 'tools and technical' criteria listing.
- Boston Framework: the Boston framework was selected as it represents a use-case approach to checklist evaluations. Although the framework was used by the Boston evaluators as a simple yes/no checklist, the way the criteria were phrased were markedly different in that they encompass tasks rather than tools.
- Britain & Liber Frameworks: these two theoretically derived frameworks were selected as representing grounded approaches to checklist evaluation; Pask's 'conversational model' and de Beers' 'viable systems model'.

Each of these was completed by the author. The completed checklists are particularly large and are therefore to be found in the appendices as noted.

4.6.1.1 Using the EduTools Framework (see appendix 4.2.1)

This runs through a wide range of system tools and functions, some of which are ambiguous. For instance 'course management' could mean a lot of things, including the whole function set of the VLE. It also captures general technical aspects and issues such as accessibility. The questions are framed from a tool-oriented perspective, mostly based on what can be done with or to students. Overall this framework provides little more than a high-level syntactic gloss of a system's components and properties.

4.6.1.2 Using the Boston Framework (see appendix 4.2.2)

The questions in this framework are clearer than those in the EduTools framework and the instrument seems more inclusive. The questions are largely framed in terms of a user can perform such and such a task rather than does the function or tool exist. This provides a closer evaluation to the users' needs and language than EduTools. All that is checked however is the passive response to whether a task or function is accommodated by the system.

4.6.1.3 Using the Britain & Liber Conversational Framework (see appendix 4.2.3)

This framework, based on the principles of Pask's conversational model, other than identifying that the architecture of EEMeC could probably be used to support this pedagogical approach, does not show whether it is or can be used in this way. As it happens the potential for these formal pedagogical transactions is not realized in EEMeC as it has not been requested by the user community. The original framework, which expressly iterates the steps in the conversational model would have shown little for EEMeC. The framework does go further than the EduTools or the Boston frameworks in that it specifically addresses pedagogical processes and the activities of both student and tutor. Although the framework is far smaller than the previous structures, completing it was not easy as it required a large degree of interpretation of the evaluator's assumptions.

4.6.1.4 Using the Britain & Liber VSM Framework (see appendix 4.2.4)

The 'resource negotiation' factor assumes that resource negotiation is a prime aspect of the course or the VLE's role within it. In medicine the vocational practice of skills is dominant with knowledge acquisition, particular that generated by negotiating resources, of secondary importance; this factor is therefore not pedagogically-neutral. All of the factors in the VSM framework are intended to evaluate "whether a system can support a resource-based, student-centred teaching approach". However, the framework is limited in that it is abstract and open-ended, it only accommodates the one pedagogical model, and it fails to encompass the ways a VLE can function in blended relationships with broader course contexts, and it is essentially 'top-down' rather than 'bottom-up'.

4.6.2: Strengths and Weaknesses of Checklist Evaluations

The checklist and framework evaluations given here encapsulate the strengths and weaknesses of this approach in evaluating VLEs. Furthermore, assuming they are used objectively and fairly, they can provide a lot of technical and systems constituent information on a system so evaluated. Some go further and start to question how a system might be or is being used. This is a move away from a purely mechanistic approach to VLE evaluation, but as the instrumentation has consistently lapsed back into simplistic and formulaic checklists there is still a large degree of reductionist thought encapsulated in these approaches. As a way of comparing the seven examples given table 4.7 outlines some of the salient features of each approach.

	EduTools	**Boston**	**Britain & Liber**
Methodology	explicit	explicit	explicit
Structured framework	yes	yes	no
Degree of mechanism	high	medium	low
Adaptable	yes	no	no
Context sensitivity	none	none	none
Pre-existing evaluations	yes	yes	no
Theoretical basis	no	no	yes
Scale	medium	large	small

Table 4.7: comparison of checklist VLE evaluation instruments

The strengths of a checklist approach have been defined:

> *"this approach supports decision making by providing a structured approach, and can help prompt potential users to consider factors they might otherwise neglect" (Oliver, 2000)*

On the other hand Tergan observes:

> *"technology-based learning environments may not be evaluated appropriately by using existing software evaluation checklists. Too many features, among them features concerning the flexible structuring of content, the symbol systems used for presentation, the navigation interface, exploratory, expressive and communicative tools and the stage of learning, interact" (Tergan, 1998, pp17-18)*

User and audience specificity is also an issue. Most of these checklists are designed with specific communities and users in mind. For the VLE instruments listed here, the predominant focus is on providing information to senior managers and technical staff in order to inform decision-making and procurement processes. The individuals in these groups are highly unlikely to be users of the VLE and as such the evaluation focus is significantly distanced from the way such systems will actually be used.

4.7: Discussion

This chapter has taken a range of different approaches to evaluating EEMeC starting from a 'VLE is a MACHINE' metaphorical perspective. EEMeC's system architecture was described at a number of levels, both informally using text and simple diagrams and formally using diagrams and syntax from Unified Modelling Language (UML). Although able to render the way EEMeC functions as a machine (i.e. structurally and algorithmically) in great detail, the complexity of such representations meant that a full representational rendering was beyond the scope of this thesis.

Techniques from software metrics were also applied to core components of EEMeC's code, looking at syntactic aspects such as code density and its structure. Basic metrics of cost and productivity were also considered, although the latter was unsuccessful due to the lack of data on time spent on specific tasks by EEMeC developers. Both metrical and architectural analyses were limited in their contribution to evaluation research as there are no direct comparators or causal linkages between a VLE's architecture or its code and its value. At best these properties might be reflected in the system's performance or affordances although these properties are contextualised by the way the system relates to its context(s) of use. Cost metrics were the most directly useful as they are intrinsically value statements about EEMeC. Considering EEMeC at a machine level alone excludes information on how those costs were met, whether they represent good or bad value or who might make such judgements.

Following this, analyses were carried out on log files created by the web server and VLE application components of EEMeC. Web server logs show the growth in traffic to EEMeC over time and the periodicity of the peaks and troughs of this activity. They show that the use of EEMeC grew with increasing numbers of users and even after the user base stabilised it continued to grow, moreover this growth appears to be accelerating. The web log files also show that EEMeC is used significantly out of hours, both in the evening and at the weekend and is increasingly being accessed from computers outside the University network (although the quantity of University traffic has not decreased). There were many potential forms of analysis that were not included for the sake of time and space including 24 hour patterns for different days of the week, and 24 hour patterns for different times of the year (Edinburgh at 56°N has short winter days and short summer nights which may effect VLE use).

VLE server logs differ from web logs in two essential ways; they do not record all events but just those key points of user 'write-back' to the database, and they identify individual users facilitating correlation with other VLE data such as group and cohort membership. Of these only user logins are always triggered when a user visits EEMeC and so these were the data source used. One other difference between the web and VLE logs is that the latter identifies the user (the former is anonymous). This means that similar analyses to those for web logs could be performed but for cohort-specific data. These analyses identified the different patterns of user activity, as falling in to three different patterns; years 1 and 2, years 3 to 5, and staff.

Of the machine-informed evaluations the most useful and informative have been the log file analyses because they are able to show how the system actually has been used. The extent and patterns of use are a valuable contribution to a holistic evaluation of EEMeC and to the other metaphor-informed components of such an approach. Missing from these VLE-as-machine approaches are concepts and metrics of how a VLE is used and the ways it interacts with its context of use. This shall be the focus of the next chapter.

Chapter 5: VLEs as Organisms

5.1: Introduction

The second of Morgan's metaphors is based on considering an organisation as if it were an organism (Morgan, 1997). Although the first metaphorical perspective of 'machine' appears to be congruent with a software system, an organismic perspective on VLEs may not. After all VLEs are inherently teleological; they have been designed for a purpose. The use of this metaphor is therefore not about VLEs being in any literal sense living beings, it is about questions that can be asked as a result of taking such a perspective. Morgan draws attention to three valuable perspectives that such an approach entails:

- the relationship between the organisation and its environment, in particular the fitness of one to the other
- the internal balance between the organisation's components: social, technical, managerial, strategic and structural
- inter-organisational relations

The use of this metaphor in respect of technologies is not a new one. Winner in particular has used metaphors of technology as life forms, as well as environments and politics (Winner, 2004).

Extending organismic perspectives can draw in broader concepts of 'ecology' and 'evolution' where mutuality, niche specificity and adaptation in response to environmental pressures become available as metaphorical structures. An evaluation informed by this perspective might look at the system's interrelationships with its environment, in particular the ways in which it can fit and be adapted to environmental forces, and the extent of alignment that a VLE can have with its context of use.

Methodologically there are two steps required to consider a VLE in context; describing the use context independent from the VLE and then describing how the VLE interacts with it. This is essentially a process of identifying how 'fitted' a VLE is to its context of use, after all:

> *"the innovation may be desirable for one adopter in one situation, but undesirable for another potential adopter in different situation" (Rogers, 1995, p12)*

Fitness is therefore a relativistic concept; an entity is fit relative to a particular environment or context. In terms of genetics, fitness has been categorised as static, dynamic or coevolutionary (Lucas, 2000). Static fitness is relative to an unchanging environment, dynamic fitness relative to a changing environment and coevolutionary fitness where other entities are involved. Although teaching and learning environments are rarely, if ever, static, for the purposes of this chapter the fitness of a VLE is considered against a static context; dynamic and coevolutionary aspects will be covered in chapter nine on flux and change.

It is important to note that the consideration of context marks the departure of the two types of VLE identified in chapter two. While the metaphor 'VLEs are machines' is valid for both a VLE-in-abstract and a VLE-in-use, the additional dimensions of context and environmental factors is only relevant to a VLE-in-use. This chapter will develop a framework for considering VLEs in context and apply it to evaluating EEMeC.

In this chapter two methods are pursued in considering EEMeC as an organism; the development and application of a framework to create an ideographical account and evaluation of the different contextual fitness factors for EEMeC, and the analysis of some of the extrinsic properties of the Edinburgh MBChB learning environment as a whole. Operationalising the evaluation of a VLE's fit to its context of use could however be pursued in a number of other ways, including its compatibility with the procedural, economic or cultural aspects of the context of use (covered in part in chapter seven), or its reflection of the values and political makeup of the context of use (covered in chapter ten). Issues of the crossover between different metaphors and derived methods will be considered in chapter twelve.

5.2: VLEs in Context: Environment and Fit

Morgan proposes five factors in determining the degree to which the organisation fits with its environment (Morgan, 1997, pp56-57), based on the nature of its environment, its strategies, the technologies it employs, the dominant 'ethos' or culture within the organisation and how the organisation is structured. In education the concept of 'fit' is central to Biggs' work on 'constructive alignment', where:

> *"in aligned teaching there is maximum consistency throughout the system" (Biggs, 1999, p26)*

Biggs largely deals with traditional face-to-face learning environments, but it has been argued that constructive alignment should include all parts of the learning environment, not the least a VLE if present in that environment (Ellaway, Dewhurst et al., 2003). The learning environment itself has many components. Koper describes the learning environment as essentially social in nature and consisting of:

> *"all objects, contexts and behaviours of the actors who play a role in the development, execution and evaluation of the learning environment" (Koper, 2000)*

An optimised VLE should be aligned with all the components of the learning environment in which it is used. A VLE's fit with its learning environment should therefore be an appropriate evaluation criterion. There are three main aspects of fitness for a VLE; pedagogical, technological and organisational. For each of these there may be aspects that are broadly positive, neutral or negative.

A framework was developed describing the key aspects of a VLE's environment using techniques derived from naturalistic research and grounded theory (Strauss and Corbin, 1998). A framework was developed around observations of EEMeC's environment and its key aspects. This framework was then tested by using it to re-describe EEMeC's environment. Discrepancies and omissions were identified and used to redevelop the framework, which was then reapplied as a means of structuring a descriptive account.

The first version of the framework contained six elements based around the idea of a VLE's congruence with its context of use: procedural, logistical, educational, adaptation, semantic and external. Trialling the framework identified the omission of a number of key aspects such as fitness, both for people in groups and as individuals, and its representation of the contextual fitness for a VLE was generally unclear. The framework was redeveloped and mapped against the elements that had emerged from the initial trialling phase.

The mindmap shown in figure 5.1 indicates the larger dimensions and their constituent factors derived, both from the trialling process and from the literature (Miles and Huberman, 1994; Ford, Goodyear et al., 1996; Wenger, 1998; Biggs, 1999; Brown and Duguid, 2000; Hannan and Silver, 2000; Entwistle, McCune et al., 2002; Cornford and Pollock, 2003). This map was trialled and redeveloped once more and then presented as a framework for examining a VLE's fit to its context of use.

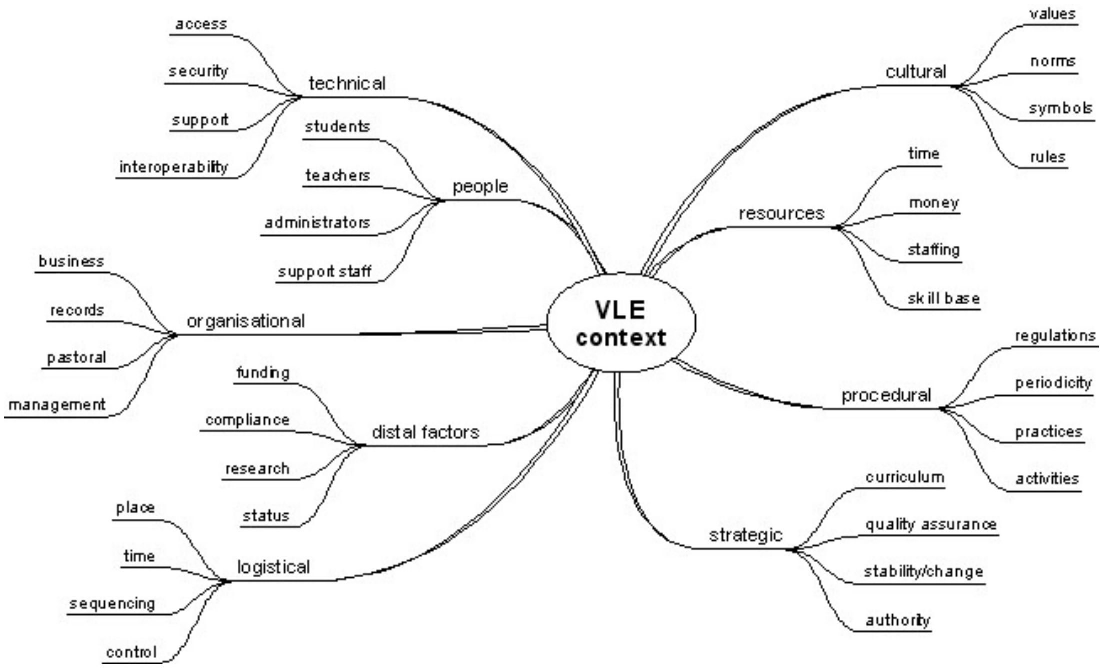

Figure 5.1: mindmap showing the main framework components for analysing a VLE's context of use.

5.3: 'Fit to Context' Analysis

Having created an evaluation framework for a VLE this was applied by the author to EEMeC and its use context and used to build up an account of the interrelationships and dependencies between the VLE and its context of use. The process of completion involved the creation of a description of how the VLE and its context interact and the rating of this against the criteria statement for each factor. The author, as the principal architect and manager of EEMeC, completed this first pass, creating an essentially ideographic account. As the environmental fitness of a VLE is essentially interpretive and therefore subjective, the use of non-nomothetical measures is an appropriate approach to take.

As a means to reduce the subjectivity of this approach and to test the application of the framework the account was next passed to three colleagues for validation: a senior EEMeC developer, a teacher on the MBChB who is also a member of the course management team and an academic external to the MBChB but with an interest in learning technologies. The points they raised concerned both the use of the framework and the clarity and detail of the accounts given. As a result of their input the description for each component was restructured in terms of the context and the positive and negative fitness factors for component, and adjustments to the language and in a few cases the interpretations themselves were made.

Ideally students and administrators would also have been involved in the validation process. However this exercise was carried out at the same time as several others that also required engagement from these groups and as this was already proving difficult they are not represented in the validation of the instrument or its application.

The resulting framework and its application to EEMeC is shown in table 5.2 (a blank version of the framework is to be found in appendix 5.1). As an attempt to bring the fitness framework evaluation together into a single representation the rankings for each of the framework components were plotted on a ‘radar’ graph as shown in figure 5.2.

Table 5.2: specific factors of VLE fitness within an educational context for the Edinburgh MBChB and EEMeC.

Factor	Descriptor & Rating	Description
1: Technical		
1.1: Access	1.1.1: The VLE should be accessible to all users irrespective of location and time. **HIGH**	*Context:* Students and staff of the Edinburgh MBChB are distributed across South East Scotland and the MBChB runs all year round. *Positive fit:* EEMeC can be accessed using any contemporary web browser and can be accessed from anywhere on the Internet. Bandwidth requirements are generally low and the system mostly uses clear HTML. The servers are run as close to 24-7-365 as is possible. *Negative fit:* EEMeC is web-only. Students or staff without access to a web-enabled computer cannot use it. Access to computers was a particular problem in the early years of EEMeC. Some system down time occurs for instance for restarts when applying system patches and updates, and occasional breaks in the network. There is a >99% reliability rate.
	1.1.2: The VLE should be accessible for different kinds of users and their needs. **MEDIUM/ HIGH**	*Context:* Accessibility (in terms of disability access) is less of an issue for medicine than for other subject areas as medical students can currently have no greater disability than minor dyslexia. Despite this around 3% of Edinburgh's medical students self-identify as having some form of disability. *Positive fit:* EEMeC uses plain text and accessibility-friendly features such as style-sheets, alt tags for images and consistent and clean layouts. *Negative fit:* A move from <table> to more accessible <div> based layouts is imminent.
1.2: Security	1.2.1: the VLE should be secure and users should be trackable and accountable for their actions. **HIGH**	*Context:* Both good practice and University computing regulations require all users to be 'known' to the systems they use for reasons of accountability. EEMeC needs to provide different forms and levels of access to different users. User accounts need to be managed. *Positive fit:* All EEMeC users have individual logins. Students can be members of a variety of different groupings and staff can have a wide range of different user types credited to their accounts. *Negative fit:* EEMeC is not part of a single-sign-on system; passwords differ between systems and can be mislaid.
	1.2.2: Information in the VLE should be held safely and securely and in accord with legal and institutional requirements. **MEDIUM/ HIGH**	*Context:* the University requires that only specific officers of the University should have access to personal information. *Positive fit:* EEMeC's hardware has been hardened against attack and is regularly backed up. Only EEMeC developers have direct access to the servers, all other access is via controlled web interfaces. All users must log in to use EEMeC. Traffic between client and server is secured using encrypted connections. *Negative fit:* without integration with the central Registry student record or data in College Office EEMeC can hold inaccurate information about students. Problems, often flagged up by student complaints, mostly take place at the start of academic sessions. A single year cohort may change ten or more times in a week, which currently requires data to be sent each time to EEMeC and manually uploaded. A major project is now under way to directly link EEMeC to data from Registry and the College Office.

	1.2.3: Access to logins and the ability to impersonate users should be available but strictly limited to those who manage the VLE. **MEDIUM/ HIGH**	*Context:* selected staff need to view EEMeC from another users perspective (usually that of a student), usually for problem solving purposes. *Positive fit:* Selected users can be given the rights to login as other users. The impersonated user's actions are not tracked. A number of 'fake' users have been seeded through the system to facilitate development and testing. *Negative fit:* Passwords are stored in the database as open text (i.e. not hashed or encrypted) and are therefore visible to EEMeC developers. Adopting a common University authentication system will remove this problem. Fake users need to be hidden when year and group lists are being used, for instance for assessment purposes.
1.3: Support	1.3.1: Technical support for the VLE should be available to ensure a continuous and high quality of service. **HIGH**	*Context:* the University of Edinburgh is divided into 3 colleges. In the college of Medicine and Veterinary Medicine there is (so far uniquely) a Learning Technology Service (MVMLTS), which has a remit that includes IT support, e-learning and medical illustration. *Positive fit:* MVMLTS run all aspects of the EEMeC service. User support is run via the eemec@ed.ac.uk helpdesk, which is received by all of the EEMeC team. EEMeC staff also run staff development. EEMeC development is carried out collaboratively with EEMeC users to ensure developments meet their needs. *Negative fit:* The EEMeC service is provided at a College level, in an environment where most large-scale systems are developed and run centrally. As a result there have been concerns raised regarding EEMeC's reliability and sustainability from central services. This is reflected in EEMeC's lack of integration with central systems and the lack of engagement from central services as a whole.
	1.3.2: Required technical support for the VLE should be minimal and easy to provide, and should build on existing skills and capacity. **HIGH**	*Context:* Central IT development in the University of Edinburgh is split between Management Information Services (MIS) and the University Computing Services (UCS). At a development level each runs different systems and employs different technologies. There is no dominant development platform or culture across the University. *Positive fit:* EEMeC runs in a Microsoft Windows Server environment, one which has proved to be relatively easy to set up and maintain. EEMeC's code has been structured to allow different developers to work on the same toolset. It has not been difficult to recruit, and when necessary replace developers as the underlying technologies for EEMeC are industry standard. *Negative fit:* At the time of development existing web and database server skills in the University were Unix only. The adoption of Windows servers was a move away from the dominant culture and was accordingly risky, in particular because skills had to be acquired within the EEMeC team. The risk was very small however and has not negatively affected the system.
1.4: Interopera-bility	1.4.1: The VLE should interoperate with all other relevant systems within its working environment. Data should be held by	*Context:* Although EEMeC has only limited interoperability with other University systems although not for technical reasons. Central information system managers have not prioritised EEMeC connectivity, preferring to concentrate on institution-wide developments. There is also a culture of caution about exposing their systems to 'outsiders'. In addition the senior administrators for the MBChB have decided over the years not to seek direct interoperability with either central or local administrative systems although this situation is changing (note that administrative and academic aspects of the MBChB are managed relatively independently).

	single systems and distributed and shared as necessary. **MEDIUM**	*Positive fit:* There are no technical barriers to EEMeC's interoperability with other systems. Where the opportunity to interoperate with other key systems has been available, such as with the library or the devolved ATHENS authentication service, links between these systems and EEMeC have been easily and effectively established. *Negative fit*: EEMeC is dependent on the political dynamics of its local and organisational contexts. If the will to allow EEMeC to interoperate with another system is not there then links cannot be established, no matter how easy or effective such joins might be.
	1.4.2: The VLE should employ appropriate interoperability standards and specifications so that information and content can be moved from system to system and the system can interoperate with other relevant standards-based systems. **MEDIUM**	*Context:* interoperability standards and specifications for learning technologies are increasingly common. Within the University of Edinburgh, although some systems employed have some interoperability implementation (e.g. WebCT and QuestionMark Perception) there has so far been little practical institutional interest in interoperability. This is in large part because those involved are not engaged with learning technology cultures but rather those of enterprise and business systems development. *Positive fit:* EEMeC has some standards-based interoperability compliant tools (e.g. IEEE LOM metadata or SRW for bibliographic search and retrieval). However, without systems with which to interoperate, there has been little opportunity to pursue such developments. The recent emergence of a number of systems that EEMeC is likely to have to work with (such as the JISC Information Environment or the International Virtual Medical School (IVIMEDS)) has raised the need for interoperability functionality in EEMeC. Several members of the EEMeC team are active within the national and international interoperability special interest groups. *Negative fit*: EEMeC has to build its interoperability compliance from scratch. Initially that meant a rather steep learning curve developing web services and XML handling tools but this is increasingly easy as the technical implementations are all based on the same underlying technologies. The lack of 'out of the box' interoperability has occasionally been levelled as a criticism of the system.
2: People		
2.1: Students	2.1.1: The VLE should support the needs, wants and dynamics of the student population. **HIGH**	*Context:* From the outset students have demanded much of EEMeC, both in terms of quantity and quality, including more consistent and accurate provision of information and resources and requests for additional functions and features. Students drove the introduction of discussion boards and push their tutors to use EEMeC. *Positive fit:* feedback is channelled through the EEMeC help desk, the MBChB's various committees (which mostly have some form of student representation) and from occasional user and focus groups held to concentrate on EEMeC provision and development. The patterns and degrees of use elicited from the web and VLE server logs shown in the previous chapter indicate the extent of use that students make of the system. *Negative fit*: At the start of EEMeC's development student involvement was greater than at present (from ~4 meetings a year to ~1). This has been for a number of reasons: at the start there was more to change and improve; the novelty encouraged involvement; and EEMeC has over time become less of a novelty and is now increasingly normalised within the MBChB.

	2.1.2: The VLE should support students at different stages of their course and in different situations. **HIGH**	*Context:* The MBChB degree programme lasts for 5 years, around a third of second years take an additional year-long intercalated honours science degree and around 25 students have direct entry to year 3 from other University degree programmes. *Positive fit:* As EEMeC identifies each user as they log in, their experience can be tailored to their particular stage in the MBChB programme. In particular the 'My EEMeC' page is designed to provide links to the specific parts of EEMeC that are relevant to a user's position within the programme. Different users get different things. *Negative fit*: Some of the intercalated honours pages need to be accessed by non-MBChB students from other colleges. This has caused problems when these students are expecting to access their materials through WebCT.
	2.1.3: The VLE should support the diversity of approaches and needs of its student users. **MEDIUM/ HIGH**	*Context:* Students will need to follow and record their own learning experiences and their own education and development throughout the MBChB programme. Personal Development Profiles (PDPs) need to be established University-wide by January 2006. *Positive fit:* EEMeC can record personal annotations, provides a personal portfolio, and hosts personal home and project web pages. At a social level EEMeC discussion boards have been used for amongst other things; announcing engagements, conducting arguments and once as a book of condolence. *Negative fit*: PDPs are an essential part of the curriculum, but are not yet maintained on EEMeC. A decision on University policy regarding such records is awaited.
2.2: Teachers	2.2.1: The VLE should allow teachers to easily and effectively design, organise, deliver and assess teaching and learning processes. **MEDIUM/ HIGH**	*Context:* Course materials and services need to be refreshed and/or developed on a regular basis and other course business and transactions need to take place with the minimum amount of effort and fuss. *Positive fit:* currently the EEMeC development team undertakes the majority of data-handling, setup and design work on behalf of the MBChB community. Increasingly staff are being given tools to manipulate and manage EEMeC data and services directly. Edit access to the content management system has been developed and timetables can be directly uploaded and amended by year and module secretaries. *Negative fit:* The amount of direct authoring and editing within EEMeC by academics and teachers is currently limited to a relatively small number of core teachers and administrators.
	2.2.2: The VLE should support the pedagogical approaches required by the teacher and the course in general. **HIGH**	*Context:* The Edinburgh MBChB has undergone many changes over the years, including changes in pedagogical approach and organisation. *Positive fit:* Because much of EEMeC is developed in response to requests from individuals and committees within the course there is a high degree of *a priori* congruence between the system and the context it serves. The distribution of enthusiasm for using EEMeC among the teaching population has grown steadily, with a core of active enthusiasts and sceptics outlying a larger number of relatively passive users. *Negative fit:* New ways of working have had to be developed to better facilitate non-technical users specifying and developing applications and tools with EEMeC technical developers.

2.3: Administra-tors	2.3.1: The VLE should facilitate easy, reliable and secure administration of course processes. **MEDIUM**	*Context:* all undergraduate medical courses require a high degree administrative input to maintain the logistics, information and quality assurance aspects of the programme. In Edinburgh this is undertaken by College Office. *Positive fit:* Although it is not a comprehensive course administration system, a number of key administration tasks are carried out within EEMeC. These include communication with students using EEMeC's notice boards, managing summative assessment data and providing logistical support via the timetables and course documentation. Staff development has been relatively low-key, both because of the relative ease of use of the tools and also because users have been involved in the development of the tools and are therefore able to shape how they are to be used and learn to use them as part of the development process. *Negative fit:* there has been an ongoing reluctance among the administrative managers to engage with or use EEMeC to any great extent.
2.4: Support staff	2.4.1: The VLE should facilitate easy, reliable and secure support of course processes by appropriate staff. **HIGH**	*Context:* Course support roughly falls into the following categories: library, teaching facilities, IT and learning technology *Positive fit:* The senior liaison librarian for medicine has used EEMeC extensively for providing teaching materials. In addition the d+ connector allows library systems (which are run centrally in Edinburgh) and VLEs like EEMeC to share information and interoperate. Teaching spaces and audiovisual support is provided through the College room booking system which runs as an EEMeC subsystem. The EEMeC team can draw upon intra-section IT support. Student and staff users are supported by college or central computing officers (depending on which facilities they are using). EEMeC as a web-based system requires little or no user support in terms of IT other than occasional issues over using certain types of media. These enquiries are largely dealt with by the eemec@ed.ac.uk helpdesk. In this respect, as the developers are running the system, support is immediate and integrated into the general running of EEMeC. Care is taken however in ensuring that no more access to EEMeC is given than is needed by non-EEMeC team members. *Negative fit:* The exception regarding IT support is the administrative staff and those working in their vicinity (who include the core academic management team) who use separate support and a different common desktop (from MIS). Although this gives them common tools and workspaces, these are not available to non-MIS users and the service is quite constrained as regards using multimedia and systems development tools.
2.5: Course Managers	2.5.1: The VLE should meet the requirements of the course's strategy and policy makers and it should facilitate course management. **MEDIUM**	*Context:* The MBChB is governed by a number of strategic, policy and procedural committees. There are also external liaison and policy groups that involve only academics, administrators or technologists. *Positive fit:* EEMeC has been built within the MBChB and is therefore a reification of its strategy and policy. It increasingly acts as a knowledgebase for the course providing a commonly accessible master copy of current and historical content and activity. Operational policy is mostly devised dynamically between senior academic managers, the EEMeC manager and the EEMeC team. EEMeC representatives attend most MBChB committees. *Negative fit:* EEMeC is managed at a strategic level by an 'EEMeC Executive' committee. However as this meets on a very occasional basis it has proved to be relatively light in touch and has tended to

		rule on what EEMeC will not do rather than what it will do. In addition senior MBChB administrators are setting up a separate system to EEMeC to hold course information in support of administration activities, indicating the relatively low level of confidence in and buy-in to EEMeC from senior administrators.
3: Organisational		
3.1: Strategic Management	3.1.1: the VLE should support the organisation's strategic goals. **HIGH**	*Context:* The University of Edinburgh is the largest university in Scotland and is a member of the Russell Group of the top research institutions in the UK. *Positive fit:* EEMeC supports the strategic goals of the University by the quality of service offered, its creative and dynamic ongoing development and its support of a single but important course context. EEMeC, along with its sister VLEs, is the University's submission to the Queen's Anniversary Prize for Higher Education in 2005 as its exemplar of excellence and innovation in teaching and learning. *Negative fit:* Although academic medicine is important to the institution it is only one among many disciplines and activities of the institution. There has been a central policy to get as many courses as possible using the institutionally provided VLE, WebCT. In early drafts of the University's Knowledge Management Strategy a move to WebCT as the only permitted institutional VLE was stated as a strategic goal (it was later removed).
3.2: Operational Management	3.2.1: the VLE should support the organisation's operational goals. **MEDIUM**	*Context:* The University of Edinburgh has more than 200 undergraduate degree programmes; EEMeC supports just one of them. *Positive fit:* EEMeC is able to support the MBChB in a wide variety of ways. EEMeC has been provided by the College, which has relieved central services of the responsibilities of providing these services to the College. *Negative fit:* There is a general move in the University towards centrally managed systems including those that support educational processes. EEMeC in being devolved from the centre has often been sidelined in institutional developments as it is seen as peripheral to such developments. In addition, because of the relative disengagement from EEMeC by senior College administrators there are committees and policies regarding student systems that remain opaque to the EEMeC development team.
3.3: Information Management	3.3.1: the VLE should support the organisation's information goals. **MEDIUM**	*Context:* Registry holds the definitive student records and College Office the definitive course records for the MBChB. Quality assurance procedures are required by the College and the University, by the Scottish Higher Education Funding Council (SHEFC) and for medicine by the UK General Medical Council (GMC). *Positive fit:* EEMeC plays a major role as part of the operational record of the MBChB course. At the end of every academic session EEMeC is archived and a live working copy made available to its user community. The MBChB course evaluation process is now run entirely through EEMeC. *Negative fit:* audit, for instance assessment profiles of students and cohorts, is carried out on a regular basis, although as the College decided not to maintain timetables in the clinical years this is limited in effectiveness.
3.4: Pastoral Management	3.4.1: the VLE should support the	*Context:* The University runs a Director of Studies (DOS) programme, it retains an active student association and in medicine there are a number of specific student groups and councils.

	organisation's pastoral goals. **MEDIUM**	Individual pastoral support is provided by the student's DOS and by the various counselling and chaplaincy services. *Positive fit:* The DOS programme is fully mapped into EEMeC, as are the social aspects of the course via the discussion and notice boards. Student representatives are elected using EEMeC as a balloting mechanism, and links to the Medical Students' Council and the student association are maintained within the system. *Negative fit:* There are no links in EEMeC to non-medical student associations or to centrally-provided pastoral support services although, as medical students tend to be relatively autonomous of central student activities, this is not a major issue.
4: Logistical		
4.1: Place	4.1.1: the VLE should support the course across its various locations. **HIGH**	*Context:* The Edinburgh MBChB is conducted in the central University area, in the two major teaching hospitals in the city and in most of the GP clinics, district general hospitals and other healthcare centres across southern, central and eastern Scotland. Students also take an overseas elective in year 5. *Positive fit:* EEMeC is web-based and is accessible from any of the locations at which the course is conducted, including the homes and vacation locations of both students and staff. The log analyses carried out in the previous chapter show the large proportion of EEMeC traffic that emanates from outside the University's network. *Negative fit:* Occasional difficulties have been experienced with firewalls onto NHS networks and with connecting to the student halls of residence but these are minimal.
4.2: Time	4.2.1: the VLE should support the course's temporality. **HIGH**	*Context:* The MBChB, like medicine is always active. Students on clinical placements will work weekends, and will need to work around the many discrepancies between University and local NHS holidays. The server logs show a great deal of activity in the evenings and at the weekends. *Positive fit:* EEMeC is available as close to 24-7-365 as possible. The server log analyses in the previous chapter show how much access is made of EEMeC outside of working hours and at weekends. *Negative fit:* If there is a server problem at the weekend or in the evening then either staff must come in to sort the problem or it is left until the next working day. The need for physical access to the servers has been reduced recently by using remote desktop client tools (RDCs). The remaining issue is one of monitoring so that problems are detected out of hours. This is usually brought to the EEMeC team's attention by student emails, although automatic alerting systems are currently being developed.
4.3: Sequencing	4.3.1: the VLE should support the course's periodicity. **MEDIUM/ HIGH**	*Context:* The Edinburgh MBChB's first two years follow the same pattern as the rest of the University; this used to consist of three terms but moved to two semesters as of autumn 2004. The last three years follow a separate pattern; for instance years 4 and 5 start in July rather than in September. *Positive fit:* EEMeC is not subject to the service interruptions and close downs that effect central systems such as the centrally provided VLE, the library and student computing labs. EEMeC is therefore able to continuously follow all five years of the course. *Negative fit:* Moving EEMeC from one academic session to another can be problematic, particularly in terms of assessment and evaluation, which inevitably fall at the end of the academic year. There is often a delay at the start of each academic year between

		new session materials being provided and these materials being made available. This is being addressed by moving content authoring and management within the system itself.
4.4: Control	4.4.1: the VLE should support the course's control of its logistics. **MEDIUM**	*Context:* the Edinburgh MBChB is very complex with students following convoluted timetables at many locations and with many different members of staff. *Positive fit:* EEMeC provides full personal timetables for students and staff in years 1 and 2 (and technically could for the other 3 years). This coordinates people, teaching spaces and other resources to a fine degree of detail. The archive, the portfolio and the assessment engine all provide tools for monitoring and analysing student activity. Log files provide tracking for particular aspects such as discussion board posts and annotations. *Negative fit:* because it has proved difficult to obtain student-specific timetables for clinical attachments EEMeC timetables do not cover years 3, 4 and 5, despite having the technical facility to do so. The absence of any timetable information for later years students has both inconvenienced students and meant that *post hoc* audit of teaching time has been that much harder. Moves are underway at the time of writing to reinstate timetables for all years.
5: Cultural		
5.1: Values and Norms	5.1.1: the VLE should support the course's values and norms. **HIGH**	*Context:* Medicine has been taught in Edinburgh since the eighteenth century. The current MBChB programme is designed to continue the traditions of academic medicine, educating doctors to have a strong research, evidenced, reflective basis to their professional practice. *Positive fit:* EEMeC has been built from within the MBChB. The values and norms of the course are reflected in EEMeC's architecture and processes and in its rules and controls. *Negative fit:* The Edinburgh MBChB has traditionally been a conservative entity. Although EEMeC was developed at a time of innovation and change in the course, many staff remain attached to traditional methods of teaching and learning and use EEMeC only as a peripheral component in their practice.
5.2: Symbols	5.2.1: the VLE should support the course's epistemology, language and terminology. **HIGH**	*Context:* the MBChB is typical of most UK medical courses in that it is taught largely by clinicians and biomedical scientists – the MBChB's culture reflects that of its practitioners. Edinburgh also engages with other medical schools in Scotland, the UK and worldwide and shares a common medical education culture with them. *Positive fit:* EEMeC has been built from within the course so as such it is imbued with the epistemology, language and terminology of the course. For instance the language and practice of periodicity (rotation, attachment, carousel), activity (OSCE, SCEE, clinic), and structure (vertical theme, intercalated, elective) is a fundamental part of the system. *Negative fit:* Although there is coherence within the MBChB, much of its language is not recognised in educational contexts outside of medicine. This has consequences for interoperability with external systems that do not share the same cultural background.

6: Resources		
6.1: Time	6.1.1: the VLE should be time-efficient. **MEDIUM/ HIGH**	*Context:* Medical education is complex and costly, reflected for instance in the higher *per capita* funding for medical students from the funding councils. Efficiency is, to an extent, a relative concept and as this is not a comparative evaluation there is no absolute measure of efficiency. Comparisons can be made longitudinally however. *Positive fit:* task complexity has been redistributed, with the EEMeC team taking on a significant amount of data handling and preparation. EEMeC has also allowed processes to be run differently than before. For instance communication with students is now far quicker and materials can be circulated electronically without recourse to printing or physical distribution. *Negative fit:* Not all of the processes that support EEMeC are time efficient at every stage. Data preparation may be as time consuming as before, i.e. planning timetables, but the result is then both richer and more dynamic, leading to time savings later on.
6.2: Money	6.2.1: the VLE should be cost-efficient. **HIGH**	*Context*: Although medical education attracts higher levels of funding in the UK than for other subjects in higher education, programmes consistently run below optimum resource levels for what they are expected to do. *Positive fit:* The cost to the College for the services provided by the e-Learning Unit (including EEMeC) are two fulltime posts and some of the on-costs for a team of nine (such as accommodation and utilities). In this respect EEMeC and all of the other services provided by MVMLTS e-Learning are highly economical for the College. Other savings include a major reduction in printing costs as a result of placing materials online, the electronic portfolio drastically reduced an otherwise massive administrative workload and the offset of many information-handling tasks from other staff to the EEMeC team has created capacity in the course community as a whole. *Negative fit:* EEMeC is not cost-neutral: for instance the cost of EEMeC per student per academic session for a student has been established at around £70-75. In addition to the development costs, time is spent by staff involved in managing information and services that run through EEMeC. However, most of these activities are ones that would need to take place anyway. Another offset cost is that of not using alternatives to EEMeC. Edinburgh has WebCT as its centrally provided VLE. It has been argued that the College is paying for two VLEs despite WebCT not being a viable alternative.
6.3: Staffing and skill base	6.3.1: the VLE should fit the profile of staffing and the skills of staff in the course. **MEDIUM/ HIGH**	*Context:* The Edinburgh MBChB (as with many others) takes place either within a university or clinical context. In neither location is education the primary priority. There is a relatively small core team of staff dedicated to designing, managing, supporting and administering the MBChB with the majority of teaching staff focused on research or clinical work (and often both). *Positive and negative fit (it is hard to separate these for this factor):* since EEMeC has been developed within the MBChB it has been both facilitated and constrained by the available staff roles and skills. The particular abilities and influence of individuals have been as much a factor as the general profile of roles and responsibilities. For instance the enthusiasm of some module leaders and the scepticism of others has distinctly coloured their use of EEMeC and the benefits achieved. As the skill base and

		attitudes of staff have changed EEMeC has changed as well. This is a useful indicator of the opportunistic nature of EEMeC development as some strategic approaches have foundered on the inability or unwillingness of certain staff to implement strategic change.
7: Procedures		
7.1: Core heuristics and peda-gogies	7.1.1: the VLE should support the course's approach to teaching, learning and assessment. **HIGH**	*Context:* Undergraduate medical courses tend to have either systems- or case-based curricula. The Edinburgh curriculum is based on a core systems model but is increasingly employing case- and problem-based methods of teaching throughout the course. *Positive fit:* EEMeC has followed local approaches to teaching, learning and assessment as closely as it can. In particular EEMeC has tended to be used as a support for innovation in teaching and learning, for instance virtual patients, problem-based learning and peer assessment have all been developed using EEMeC as a core medium. At a more strategic level the assessment engine is being developed to manage the whole of the MBChB's summative assessment processes. *Negative fit:* The Edinburgh course is still predominantly taught face-to-face; as such EEMeC is the primary medium for only selected parts of the course.
7.2: Practices	7.2.1: the VLE should support the course's practices and activities. **HIGH**	*Context:* The Edinburgh MBChB has a very full and diverse curriculum. *Positive fit:* EEMeC has been intrinsically built around the MBChB is therefore very well aligned with it. For example, the noticeboard provides an efficient and well-used medium for keeping the course community informed of developments and changes in the MBChB. Other examples include the timetables, the content management system and the use of learning resources. *Negative fit:* As was mentioned earlier the Edinburgh course is still predominantly taught face-to-face; as such EEMeC is the primary medium for only selected parts of the course.
7.3: Regula-tions	7.3.1: the VLE should support the course's rules and their enforcement. **MEDIUM/ HIGH**	*Context:* The University has a duty to ensure that all its staff and students that are working in clinical contexts behave appropriately and accountably. In addition to their matriculation contract with the University, medical students are also required to sign up to a medicine-specific code of practice. *Positive fit:* All student and staff contracts and codes of practice cover online behaviour and transgressors can and have been disciplined. All EEMeC users are required to resign the University's computing regulations when they first login to EEMeC. *Negative fit:* Discussion boards (the main opportunity for inappropriate behaviour in EEMeC) are policed by the students, not by staff. It is possible that incidents may go unreported while innocuous activity may be challenged for questionable motives.

8: Strategy		
8.1: Curric-ulum	8.1.1: the VLE should support the course's curriculum. **HIGH**	*Context:* In 1998 the Edinburgh MBChB curriculum was relaunched as a response to the GMC's changing requirements. The curriculum has undergone a series of modifications since then, the most recent of which was the move from a three term to a two semester year for years 1 and 2. *Positive fit:* EEMeC is fundamentally tied to and built around the new MBChB curriculum. Indeed EEMeC was originally conceived as an 'electronic curriculum' and it still bears the title. Recently the codification and management of learning objectives has raised the prospect of detailed curriculum maps being part of EEMeC. *Negative fit:* Some problems were experienced supporting students who had transferred from the old to the new curriculum by taking an intercalated year or by having to retake years.
8.2: Quality assurance	8.2.1: the VLE should support the course's quality assurance and audit processes. **MEDIUM/ HIGH**	*Context:* There are a number of levels of quality assurance in the MBChB: internal measures that are coordinated by the Quality Assurance Committee and which focus mostly on the 'Additional Contributions for Teaching' (ACT) and other evaluation processes; and University measures such as the Teaching Performance Review (TPR), funding council QA procedures and for medicine the regular assessments of the course by the UK General Medical Council (GMC). *Positive fit:* EEMeC supports QA processes in two major ways: firstly, all in-course evaluation takes place within EEMeC from the authoring and scheduling of evaluations through to their delivery, storage and the generation of reports. Secondly the EEMeC archive provides a living record of the course in previous academic sessions. *Negative fit:* The absence of data from EEMeC, in particular detailed timetables for years 3, 4 and 5, means that it cannot be a complete audit source.
8.3: Stability and change	8.3.1: the VLE should support the course's dynamics of change. **HIGH**	*Context*: change is a constant factor in the Edinburgh MBChB. The curriculum, assessment, sequencing, pedagogy and resourcing are all subject to change, often at short notice. *Positive fit:* EEMeC was launched to support a fundamentally new curriculum that has since continued to change from session to session. EEMeC can be rapidly adapted to mirror these changes. For instance, the node-based system allows page content and the links between pages to be managed separately. *Negative fit:* The limiting step is where new functionality needs to be developed from scratch; in these cases developments enter a development 'queue'. Depending on priority some developments are carried out immediately while others are tackled over time.
	8.3.2: the VLE should support the course's dynamics of stability. **HIGH**	*Context:* given the amount of ongoing change in the Edinburgh MBChB, there is also a need for stability and continuation. Students and staff need a solid and consistent base and need to be able to orientate themselves within the course. *Positive fit:* EEMeC supports course stability by providing a constant and easily accessible reference and communication platform for the whole course community; students in later years of the course have often remarked that they value the constancy of EEMeC in a course that rapidly changes and asks so much of them. *Negative fit:* EEMeC has changed significantly over time which has sometimes led to pockets of lost information

8.4: Authority	8.4.1: the VLE should support authority within the course. **MEDIUM/ HIGH**	*Context:* Although students are encouraged to develop their own approaches to learning there is still a structure for authority in the course. In particular authority in managing assessment and in maintaining appropriate behaviour within the student (and staff) bodies. *Positive fit:* The rights of individual users are constrained to their profile in the system. Rights are based on opening access only as and when it is required. Authority is also reified in the noticeboard as only authorised staff can post messages there (as opposed to the discussion boards). Learning materials (and other resources) are only provided on the instruction of an authorised member of staff. Tracking user activity (for instance in discussion boards) also facilitates course authority. *Negative fit:* The use of EEMeC has created new issues and demands for authority, for instance in policing appropriate behaviour in discussion boards, in compliance of students using mandatory EEMeC functions for their studies (such as the portfolio) and in the security and reliability of EEMeC as a whole.
9: Distal Factors		
9.1: Funding	9.1.1: the VLE should fit the general funding environment. **MEDIUM**	*Context:* Funding for EEMeC may come from the College, the University, the funding councils, from other public bodies (usually in the form of research funding) and from charities and private organisations. *Positive fit:* Although the University only funds two posts directly there are nine members of the e-Learning team that manages EEMeC. EEMeC fits well with the funding environment as it is able to lever external funds to deliver local capacity and opportunity. *Negative fit:* WebCT and Blackboard dominate VLE development activity. EEMeC, as a home built system, is limited in its ability to make a mark in broad VLE contexts.
9.2: Compli-ance	9.2.1: the VLE should fit the general compliance environment. **HIGH**	*Context:* In the UK the General Medical Council (GMC) regulates, inspects and licences all medical schools. The funding councils and the University also have compliance requirements. *Positive fit:* EEMeC has been able to support the inspection process and it has been commended by the GMC. The University and the Scottish Higher Education Funding Council (SHEFC) also have inspection processes but EEMeC has not been involved with these so far. *Negative fit:* The lack of joins from EEMeC to central data sources obliges multiple non-linked copies of student data that can often become misaligned, meaning EEMeC breaks data protection principles.
9.3: Research	9.3.1: the VLE should fit the general research environment. **HIGH**	*Context:* Medical education has a strong research focus and student use of the medical evidence base is a fundamental part of its practice. *Positive fit:* EEMeC has been the subject of many journal publications and conference papers. Many other academics use EEMeC as a medium or data source for research activities and many students conduct research projects with the support of EEMeC tools and resources. *Negative fit:* Over time there have been issues over data ownership and the anonymisation of student data for use in research.

9.4: Politics and status	9.4.1: the VLE should fit the general political environment. **HIGH**	*Context:* The Edinburgh MBChB is one of five undergraduate medical courses in Scotland and one of more than 30 in the UK as a whole. *Positive fit:* EEMeC is increasingly being recognised as a 'gold standard' VLE for medicine. An indicator of this is the repurposing of EEMeC for use in different circumstances, such as supporting the World Health Organisation's 'Health Academy'. *Negative fit:* An increasing monocultural approach to VLEs is emerging across the HE sector and in these contexts EEMeC can be seen as iconoclastic. Some other medical schools have abandoned purpose-built VLEs in favour of a single institutional system despite evidence of the destructive nature of such moves.

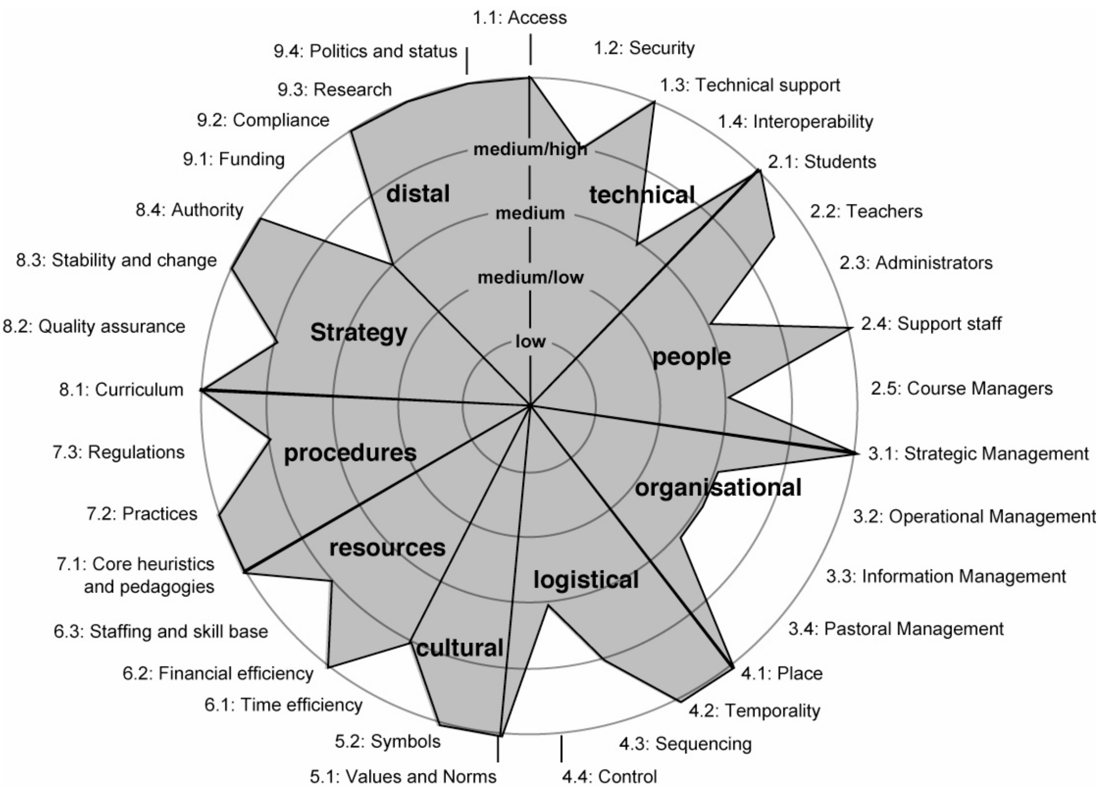

Figure 5.2: a graphical representation of the EEMeC fit to course context evaluation from table 5.5. This is a 'radar' plot with each spoke representing one of the 33 factors. The radial scale is based on isobars with the centre of the plot equal to no fit and successive isobars equal to medium/low, medium, medium/high degrees of fitness and a high degree of fit at the perimeter of the plot.

5.3.1: Discussion of the 'VLE Fit to Context' Analysis

The fitness analysis (table 5.2 and figure 5.2) covers a wide range of criteria and allows for a good deal of discussion and reflection of the foreground and background dimensions of the VLE's relationship with its context of use. In particular it provides a number of levels to the 'VLE fit to context' analysis framework:

- *Framework components*: the 9 top level components and the 33 second level factors provided a wide range of opportunities to reflect and record the nature of the VLE's fitness to its context. So much so in fact that there is a degree of overlap between certain factors. At the same time there has been no systematic review to prove that these factors are exhaustive, derived as they are from principles of grounded theory, practical experience and from a range of literature sources. Furthermore they may not necessarily be appropriate for any other VLE use context. The intent at this stage has been to develop an illustrative framework that is able to draw out and structure reflections and ratings of a particular VLE's fitness to a particular context of use.
- *Fitness statements:* the idealised statements that accompany each fitness factor were developed as a means of operationalising it into a form that could be more directly responded to, and used to rate the VLE. It is probably important to note that these statements are relative to the context in consideration. If the context is dysfunctional in some way then maybe a VLE should not fit the context but should challenge and address the problems it has. This is an important issue in considering fitness as the context can easily be taken to be immutable and idealised, whereas it may in fact be far from either state.
- *Descriptions:* the structuring of the discussions into a general context and a positive and negative statement allows both an exposition of the context's contexts and it facilitates reflection and a more equable evaluation of the VLE against the factor in hand. This was added as a response to validators' comments that in places the evaluation seemed rather one-sided and partial. By obliging the evaluator to make both positive and negative reflections the subsequent fitness ratings are far more accountable and related to the explicit evaluations made.
- *Fitness Ratings:* these are made relative to the balance of positive and negative descriptions for each factor. To an extent the weighting given to each is dependent on knowledge of the VLE and context in question and as such is less transparent than it might be. Although this is an ordinal rather than a cardinal rating this is probably the weakest part of the framework and associated methodology.
- *Aggregation and Representation:* the radar plot (figure 5.2) is intended to be illustrative rather than a mathematical representation, in particular because of the ordinal and interpretive nature of the fitness ratings that it is aggregating together. For EEMeC and the Edinburgh MBChB the graph can be interpreted as indicating that distal, strategic and procedural fitness is greater than for people or organisational fitness.

Despite its limitations, the breadth and depth of the fitness analysis is far greater than that for the checklist and log analyses of the previous chapter, although substantially less quantitative and objective.

In addition to the specific descriptions of EEMeC and its context, the evaluation draws out a number of recurring themes:

- The nature of the MBChB environment and of EEMeC's adoption and use is quite politicised. For instance the MBChB's administrators chose not to engage with EEMeC development process until it had become established with the students, and central University services have tended to disregard EEMeC as a peripheral activity until quite recently.
- There is a marked difference between technical functionality and practical utility. For instance EEMeC timetables are available to the whole MBChB but are only used in years 1 and 2 where they can be guaranteed to be complete.
- The tension between centralisation and devolution of activity is a constant dynamic in the MBChB and in the use of EEMeC. If there is a continuum between totally centralised and totally devolved activity then EEMeC sits somewhere in the middle of the continuum; it is a system devolved from the central provision of VLE services yet at the same time centralises activity across the MBChB. EEMeC may be seen as a centralising or devolving entity depending on the position of the observer in the continuum.
- The EEMeC development team play a central role in EEMeC. Although this is probably not surprising it is worth noting on several accounts:
    - As EEMeC increasingly provides key aspects of the learning environment then some aspects of power and control within the environment are inevitably ceded to the development team. The affordances that result from the tools and systems the developers build may both enable and constrain the actions of others in the environment.
    - VLE developers have not previously been a natural component of a medical learning environment. There are tensions regarding their status and the way they bring new aspects of their community of practice to the learning environment.
    - Unless the development team is closely linked to the environment into which they are delivering their systems then there are likely to be discontinuities between tool function and affordance in context; the developers need to be directly engaged with what is actually being done with their systems, and they need to take a critical and reflective research-focused approach to their work and to its contexts of use.
- The range of medicine-specific structures and processes that need to be supported is quite broad. Although there are inevitably quite generic activities such as lecturing and aspects of assessment there are many others that are medicine-specific, for instance the primacy of GMC regulation, the geographical dispersal of activity and the socialising dimensions of the curriculum.

5.4: Statistical Modelling of VLE 'Fitness'

Although the 'fitness to context' analysis of the previous section has provided a rich and insightful account of the interdependencies between EEMeC and its context of use, it is an inherently qualitative approach and as such has no quantitative metrics of fitness or alignment. Indeed although it is far richer, it is not unrelated to the checklist approaches explored in the previous chapter, its main conceptual difference being that it is a historical and anthropological representation rather than a technical and predictive one. This section looks at quantitative metrical means of fitness analysis.

5.4.1: Fitness Metric Options

The basis of such an analysis will consist of objective and quantifiable data about the environment, the VLE and their fitness to one another. Data on the environment can be obtained from the student record and from the prospectus. However, metrical data on EEMeC (or any other VLE) is generally not equivalent to fitness analysis as this is a function of affordance, use and adaptation rather than of inherent system properties. If fitness metrics for a VLE cannot be obtained independent of its context of use then the third step of comparing the environmental and VLE metrics cannot take place.

If therefore there are serious limitations to a metrical approach to analysing fitness then how much can realistically be done? And more importantly what can we get from a metrical approach? The rest of this section explores some approaches to obtaining metrics for the learning environment of the Edinburgh MBChB, which can at least illustrate and substantiate some of the more qualitative data presented in the previous section.

5.4.2: Data and Definitions

The data for this analysis were obtained from the University's student record database run by the Registry, and were provided as two text files, one giving a list of every programme with the duration and number of registered students in 2003-4, the other indicating the automatic seeding of programmes with courses. This latter indicates where non-optional courses are found in programmes of study. These were analysed as 'programmes' and 'seeding'. A definition of the terms used would be useful at this stage:

- Programme: the combination of units of study that are award-bearing.
- Course: the self-contained unit of study that has a summative assessment component at its end. In a modular programme this equates to a discrete module, in an integrated programme this equates to year, term or other assessed division of study.

The University of Edinburgh operates a modular programme for most of its degrees, the exceptions being professional programmes such as medicine, veterinary medicine, and education.

5.4.4: Programme Analysis

In the 2003-4 academic session there were 680 discrete undergraduate programmes of study at the University of Edinburgh. Of these, 193 had no students registered to them at all, 86 had 1 student registered, 181 had between 2 and 10 students registered, 69 had between 11 and 20 students, 84 between 21 and 50 students, 45 between 51 and 100, 14 between 101 and 200, 13 between 201 and 500, 3 between 500 and 600 and 2 with over 1000 students. The 193 programmes with no students registered on them were disregarded. The programmes with no qualification that were held for visiting students and internships accounted for 682 students. These were also disregarded.

Two statistical analyses were performed. The first was a measure of the number of students per year per programme and took the form of a frequency analysis as shown in figure 5.3. The second was a scatter plot showing the relationship between the numbers of students and the duration of each programme as shown in figure 5.4.

Although these analyses say little about the internal learning environment of a programme they do show some of the ways in which the MBChB stands out from other degree programmes in the University. Figure 5.3 shows that the MBChB has a relatively high number of students per programme year, the only larger programme is that of the BSc in Biological Sciences. Those near medicine in figure 5.4 are mostly vocational programmes, the exception being History, while the vast majority of programmes have 25 or less students per programme year. Figure 5.4 shows the outlier status of medicine more clearly and again its nearest neighbours are the same as those identified in figure 5.3, indicating that the MBChB is highly atypical of the programmes of study offered by the University of Edinburgh in terms of its duration and numbers of students, and although medicine is an extreme example, vocational/professional programmes tend to show the same tendencies as medicine.

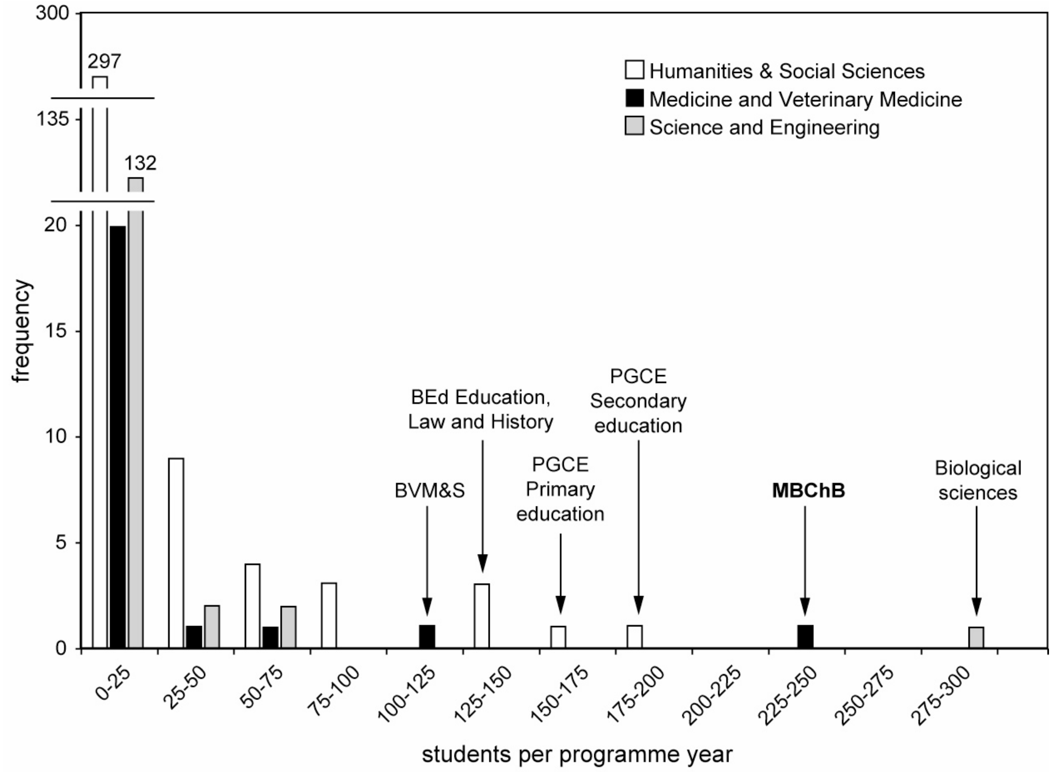

Figure 5.3: Numbers of students per programme per year for undergraduate degree programmes at the University of Edinburgh in 2003-2004

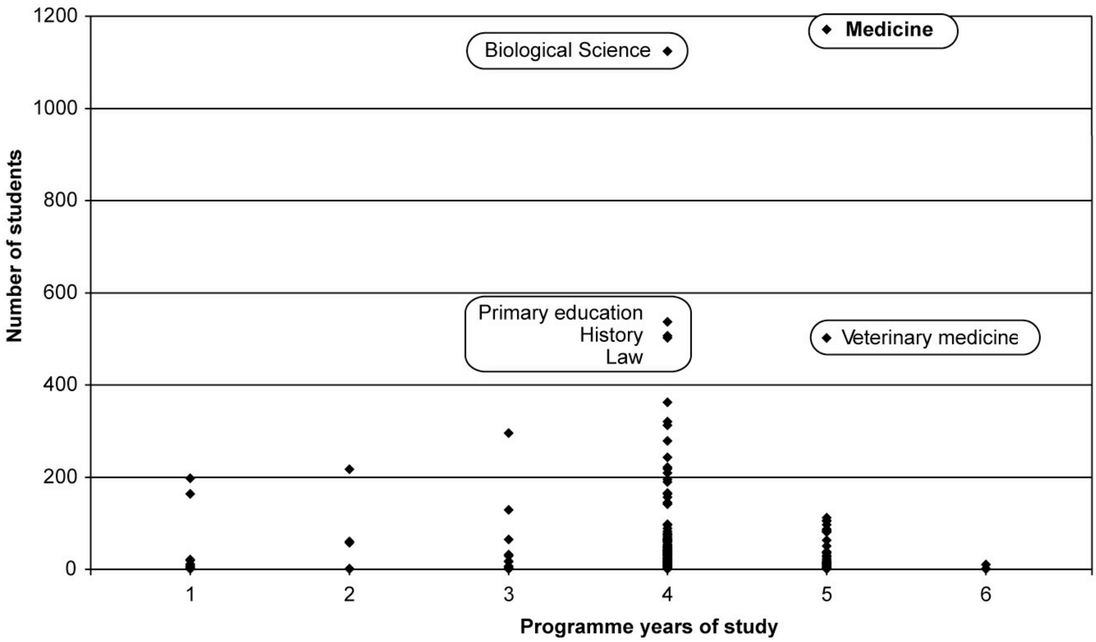

Figure 5.4: Scatterplot of programme duration against number of registered students for undergraduate degree programmes at the University of Edinburgh in 2003-2004

The fitness of an organism can be quantified in terms of the individual's ability to perform in a given environment and may be equated to specific measures of strength, endurance, adaptability, metabolic efficiency or intelligence. VLEs are however not single organisms, they are systems and their use context is the broader system of the learning environment as a whole. Metrical analyses of one system's fit within another larger system are therefore complex, elusive and limited in scope. In this case they have managed to show that some broad syntactic aspects of the MBChB are atypical relative to the University as a whole but no more than that. The qualitative 'fitness to context' analysis from section 5.3 stands as a richer, more practical and operationally more parsimonious analytical approach to take.

5.5: Organismic Alternatives

Alternatives for evaluating VLEs from an organismic perspective include:

- From an organismic perspective the ability for an entity to interoperate with its environment is a key property both of the entity and its environment. EEMeC's opportunities for interoperability with its environment are currently limited but are likely to grow significantly in the next few years as integration between University systems becomes the norm rather than the exception. The 'E-Learning Framework' (ELF) (http://www.elframework.org/) provides a service-based framework for systems like VLEs, which could be adapted to create an evaluation instrument that looks at interoperability.
- Another aspect is that of abstraction. The more abstracted a system is the more easy it should be to reconfigure it. This is balanced by the effort required to perform the reconfiguration. Thus there are likely to be optimal zones of abstraction for any system that represent this balance between adaptability and effort. EEMeC's architecture, in particular its nodal content management, are highly abstracted and simple to reconfigure.
- Similar concepts to abstraction are modularity and federation, which reflect the self-containedness of a system's functioning subsystems. From an organismic point of view this equates to body systems or organelles in cells that perform specialised tasks within the whole. EEMeC has a number of subsystems that have been developed on a modular basis although they depend on common functionality and data from across the system. Examples include the timetable, the discussion boards, the noticeboard and the portfolio.

5.6: Discussion

The focus of this chapter has been to structure evaluation and analysis of a VLE as if it had organismic properties. In particular it has investigated the ways that a VLE and its context of use inform and interact with each other. This was tackled by developing an evaluation framework and applying it to EEMeC and the Edinburgh MBChB.

Morgan identifies the weaknesses of organismic approaches as being too harmonious and singular. In reality different components of an organization may compete, disagree, misunderstand or simply fail to work with other components. Furthermore, individual motives and interactions can affect the organization in non-linear and non-adaptive ways, indeed the individual is not recognised as such in an organismic worldview; they are simply a 'human resource'. Organisms are governed by natural laws whereas organizations can display and be influenced by individual expressions of choice and intent. All of these points are equally valid for VLEs.

From a VLE perspective the organism approach has provided a range of dimensions of analysis, in particular the dependencies that a VLE-in-use has with its environment. The medical education environment is often quite different from that of other subjects in a university. As well as specific operational and logistical aspects medical education has broad differences with other courses and programmes:

> *"a particular feature of medicine and the caring sciences in general is the close relationship to fundamental human experiences such as birth, death and suffering. This adds an extra dimension of both power and responsibility to the educational process and the research activities carried out within medical faculties" (Vang, 1994, pp61-62)*

Not surprisingly a VLE that fits a medical education context does not look a lot like off-the-shelf generalised VLEs (such as WebCT or Blackboard) or other context specific web applications. Another aspect of environment is that of 'ecology' or 'information ecology' (Nardi and O'Day, 1999). Nardi and O'Day identify healthy information ecologies as being interconnected and systematic, having requisite diversity to survive both evolutionary and revolutionary change, being coevolutionary with its environment and being grounded in local settings.

By these criteria, and the other evidence presented in this chapter, EEMeC would appear to have a high degree of fitness relative to its environment, although it is not a complete fit. In the next chapter the concept of 'VLE as brain' extends the discussion on the way VLEs interact with their use contexts.

Chapter 6: VLEs as Brains

6.1: VLEs, Brains and Cybernetics

The starting point of this chapter is based on the third of Morgan's organisational metaphors, 'the organisation is a brain':

> *"Organizations are information systems. They are communication systems. And they are decision-making systems. We can thus go a long way to understanding them as information processing brains" (Morgan, 1997, p78)*

This chapter does not propose a VLE to be a brain in any literal sense. The use of the 'brain' metaphor regarding VLEs is intended to focus analysis and reflection on two themes; the flow of information and the controls within a system, and the ability of a system to learn and adapt over time. Information flow and control are the main themes of a broad discipline called cybernetics and can be pursued using cybernetic principles and approaches.

Methodologically this involved iterating the relevant cybernetic properties of a VLE and then finding a means to evaluate the VLE's support or reification of these properties (or the lack thereof). For EEMeC the latter step was achieved by developing a number of use case scenarios, validating them against the experiences of the kinds of EEMeC users they represent and then evaluating them using two cybernetic evaluation frameworks derived from the cybernetics literature.

6.1.1: VLEs and Cybernetics

Cybernetics, originating in the work of Norbert Weiner in the 1940s, covers many themes, ideas and disciplines and has many, sometimes conflicting, definitions (American Society for Cybernetics). Despite this, the following is a serviceable working definition:

> *"cybernetics treats not things but ways of behaving. It does not ask 'what is this thing?' but 'what does it do?' and 'what can it do?'" (Stuart Umpleby, 1982 in (American Society for Cybernetics))*

Central to cybernetics are ideas of communication, control and regulation, both in machine and human systems. Cybernetics also covers the ways in which human and machine systems interact. There are four essential characteristics of cybernetic systems *(Morgan, 1997, p86)*:

- The ability to sense and monitor their environments
- The ability to relate the monitoring to operational norms

- The ability to detect deviation from these operational norms
- The ability to correct deviations from these operational norms when they are detected

In terms of VLEs, only those systems that provide intelligent tutoring (based for instance on artificial intelligence principles) could meet all of these requirements. The majority of VLEs, rarely, if ever, have the ability (let alone remit) to manage learning processes at this level of control; instead they are most often configured to be part of a wider learning environment where such controls as there are split between the human and technical aspects of the system. The balance between online and face-to-face elements is encapsulated in the concept of 'blended learning' (Clark, 2003).

The use of cybernetic theory to inform VLE evaluation is not new. Stafford Beer's theories of 'Viable Systems' were used by Britain and Liber (Britain and Liber, 1999) as a basis for one of their checklist instruments (described in chapter 4). The use of this instrument for evaluating EEMeC was less than successful as the criteria are ill-defined and the approach is essentially 'top-down' and focused on a VLE-in-abstract. To evaluate a VLE-in-use a cybernetics-informed approach is required that is able to capture a contextualised setting. For the purposes of this thesis an approach was taken that encapsulates cybernetic principles of control and feedback, which can take many forms in a VLE:

- Implicit control and feedback:
    - *Access - what resources are available*. By making some things available and others not, the VLE acts as a control of a user's abilities to access information and tools. The presence or absence of a resource may either be by passive omission or active commission, for instance access may depend on a user's rights profile or simply on whether the resource has been added to the system at all.
    - *Architecture - how resources are arranged*. By reifying associations, hierarchies and other relationships between resources the VLE controls the patterns of understanding of its users. For example by separating communication and course content a VLE is transmitting messages about these connections between these aspects to its users.
    - *Articulation - how resources are manipulated*. By controlling resource manipulation the VLE can control the experience and the activities of its users. For instance a VLE may allow staff greater controls than students over what resources are available and in what order shared activities are presented.
- Explicit control and feedback: *functions of the VLE*:
    - *Tracking - passively recording activity*. By keeping logs of patterns of use, both individual and general audit and accountability is possible. In this way the VLE can passively provide information that is used to control subsequent user activity.

- *Structuring - actively directing activity.* A VLE can actively control what the user is able and/or instructed to do. For instance a user's previous activities can be used to conditionally structure their current options.
- *Compliance - actively requiring activity.* A VLE can impose compliance on its users by obliging them to complete non-elective tasks before completing elective tasks. For instance the VLE may present a form as a constant pop-up that must be completed before the user can proceed.

- Explicit control and feedback: *VLE as medium*:
  - *Tutors, experts and mentors.* A VLE can act as the medium for the teacher to instruct or otherwise construct learning opportunities for their students. Control may take the form of required activities or assessment, and feedback may be given in response to students' activities either formatively during an activity or summatively at the end of an activity.
  - *Peers and colleagues.* A VLE can act as the medium for its users' interactions with each other. Control may be exerted and feedback given in a VLE by reifying social norms in tools such as discussion boards or through more explicit activities such as student peer assessment or peer review of teachers.
  - *Support – administration, logistics and distal activity.* A VLE can act as the medium for control and feedback of support processes. For instance a VLE can be the medium for forms for applying for optional activities, it may provide the means by which non-academic support can be sought (such as pastoral or technical help), or it may provide gateway functionality to other systems such as institutional portals which provide central student and staff services.

Other forms of control are exerted by way of a VLE's cost (in terms of funds, time and other resources), the authority of the VLE developers and/or managers, and the controlling aspects of online media in general. These aspects are considered in more detail in chapters 8 and 10.

6.1.2: VLEs and Holographic Principles

All systems face challenges over time as their operating environments change. The capacity to adapt and retain focus and purpose in the face of a changing environment is another property of a VLE that can be considered and evaluated from a VLE as BRAIN metaphorical perspective. Morgan proposes concepts of 'holographic' principles as a means of modelling these properties of an organisation (Morgan, 1997, p102-115). There are five holographic principles:

- *"Build the 'whole' into the 'parts'":* a system's ability to encompass the culture, vision, purpose and philosophy of its environment, its ability to support networks of activity, its ability to retain its values and purpose as it grows and its ability to encourage and develop local skills and intelligence. From a VLE perspective this might be interpreted both as its ‘fitness to context’ (covered in the previous chapter) and how ways of using the VLE are developed by all those involved.

- *“The importance of redundancy”:* the ability and capacity of a system to innovate and develop over time. From a VLE perspective this could indicate whether adaptation and innovation is possible at all and how much effort adaptation and innovation involves.
- *“Requisite variety”:* the equivalence of complexity between a system and its environment. It has been observed that:

  > *“not only a system that is too complex but also a tool that is too simple for efficient mastering of complex problems may be dysfunctional” (Greif, 1991, p219)*

  A VLE that was too simple or too complex for its host environment would not have ‘requisite variety’. This was covered to an extent in the ‘fitness to context’ evaluation as the complexity of a given context is an inherent and dynamic quality against which fitness is measured.
- *“Minimum specifications”:* the rules and specifications that govern what can be done, when, and by whom, ideally as few as is operationally appropriate. A VLE should introduce no more rules and specifications than are absolutely necessary and it should not break those that already exist.
- *“Learn to learn”:* the ability of a system to learn and adapt in response to its own operation. As well as being a cybernetic theme this ties into concepts of ‘organisational learning’, which has been defined as having two modes (Argyris and Schon, 1978, pp18-24): ‘single loop learning’ where errors are corrected in order to adjust to meet the current organisational norms; and ‘double loop learning’ where the norms are themselves adjusted in response to incompatibilities. In terms of a VLE this could be related to the ways in which evaluation and other operational quality assurance processes are tied into system improvement and development, and the ability of the system to contribute to those processes by tracking, logging and supporting evaluation activities.

From an evaluation perspective these properties are in many ways similar to the ‘fitness to context’ criteria developed in the previous chapter. One operational would be to render the criteria as a framework and conduct a reflective-descriptive evaluation of EEMeC. However as there is already a degree of duplication between the holographic and fitness criteria explored in the previous chapter then it is more appropriate to explore alternative approaches.

Cybernetic affordances of the VLE	Access - what resources are available.
	Architecture - how resources are arranged
	Articulation - how resources are manipulated
Cybernetic functions of the VLE	Tracking - passively recording activity
	Structuring - actively directing activity
	Compliance - actively requiring activity
The VLE as cybernetic medium	Tutors, experts and mentors

	Peers and colleagues.
	Holographic Criteria
Holographic Criteria	Build the 'whole' in to the 'parts'
	The importance of redundancy
	Requisite variety
	Minimum specifications

Table 6.1: a framework of cybernetic and holographic evaluation criteria for a VLE.

Combining the control and feedback criteria with the holographic criteria provides a grounded cybernetic evaluation framework as shown in table 6.1.

6.2: Evaluating VLEs: "What can it do?"

6.2.1: Use Cases

Using Umpleby's principles of cybernetics (stated earlier) we will first consider what it is that EEMeC users <u>can</u> do. This is accomplished by developing a number of 'use case scenarios' that illustrate the range of different EEMeC user activities and interactions with the system.

The concept of the 'use case' is based on the work of Ivar Jacobson that was later incorporated into the Unified Modelling Language (UML) (previously discussed in chapter 4). Use case methodologies are mostly used for prospective planning and development of systems; their use for *post hoc* evaluation is less well established although acknowledged in the literature (Fowler, 2004). A particularly succinct overview of use cases is found in the Wikipedia:

> *"Each use case focuses on describing how to achieve a single business goal or task. From a traditional software engineering perspective a use case describes just one feature of the system. For most software projects this means that multiple, perhaps dozens, of use cases are needed to fully specify the new system … a use case defines the interactions between external actors and the system under consideration to accomplish a business goal. Actors are parties outside the system that interact with the system; an actor can be a class of users, roles users can play, or other systems. Use cases treat the system as a "black box", and the interactions with system, including system responses, are as perceived from outside the system. This is deliberate policy, because it simplifies the description of requirements, and avoids the trap of making assumptions about how this functionality will be accomplished." (Various (Wikipedia), 2004)*

Use cases within the UML are intended to capture system behaviours. Each case is designed to capture a single behaviour with variants and common factors as separate cases. A use case may be text-based or diagrammatic; the UML use case diagram being one of the five dynamic modelling diagrams in the UML (Booch, Rumbaugh et al., 1999). Outside of strict UML applications, use cases may vary in format and approach, for instance they may take the form of an unstructured narrative, a sequence of activities or a dialogue between one or more users and a system (Wirfs-Brock and

Schwartz, 2002). Use cases may be interlinked or even have dependency and they may be open ended or structured around common frameworks.

For the sake of clarity, all terms used in the use case should either be referenced in a glossary and unnecessary language and expression pared away to leave the core case. Use cases can be organised in a number of ways; by actor ('who does what', 'how and when?'), by workflow ('in what way and order do things happen?') or in a hierarchy ('what events are there and how do they relate to each other?').

6.2.2: EEMeC Use Case Scenarios

Using a single-task-per-case model to describe a complex VLE such as EEMeC would require a very large number of use cases. An alternative method is to use 'use case scenarios', an approach that uses use case syntax but permits many goals within a single case thereby providing a more holistic account of a user's encounter with the system. Use case scenarios are increasingly common in learning technology development; for instance they have been used in the development of systems such as the International Virtual Medical School (IVIMEDS) and services such as the UK JISC Digital Rights Management (DRM) research and development programme.

6.2.2.1: Use Case Authoring Process

The EEMeC use cases were written as hypothecated scenarios that were matched against general EEMeC functional areas and the different kinds of EEMeC users to ensure that the range of cases represented the range of anticipated use scenarios in EEMeC. The design grid for this process is shown in table 6.2. The scenarios were then worked up from the grid criteria and written from the perspective of each principle actor. Each case scenario is presented on a separate page and is accompanied by validation notes and issues. There is a global assumption that all principle actors have login access to EEMeC and have access to Internet-enabled computers.

Note: the use case scenarios presented here have also been used in the LTSN-01 funded 'CREAM' Project; a research and development collaboration between medical VLE developers at the Universities of Edinburgh, Newcastle, Birmingham and Cardiff.

Table 6.2: EEMeC Use Case Scenario design grid. Principle actors are matched against principle EEMeC functionality for each use case scenario. The key to the function columns is as follows: Login = a user logging in, Notices = the noticeboard (either as an author or as a recipient), Timetable = the personal timetable, Discuss = the discussion boards, Node = the node-based content management system, Annotate = the node-based annotation tools, Portfolio = the portfolio storage and marking tools, Asseng = the assessment engine, Evaleng = the evaluation authoring, delivery and analysis tools, Bookeng = the extra clinical sessions booking tools, Roombook = the College room booking system, EROS = the CAL authoring and delivery system, Search = the EEMeC content search tools, D+ = the external library search tools, ATHENS DA = devolved ATHENS authentication, Peermark = the student peer marking tools, Options = the year 2 student selected component group project work, Archive = the annual archives of EEMeC, Outcomes = the OPAL project to structure and map learning objectives and outcomes in EEMeC.

Case ID	**Case Title**	**Principle Actor**	Login	Notices	Timetable	Discuss	Node	Annotate	Portfolio	Asseng	Evaleng	Bookeng	Roombook	EROS	Search	D+	ATHENS DA	Peermark	Options	Archive	Outcomes
UC01	Year 1 student prepares for week ahead	Yr1 student	x	x	x	x	x							x							
UC02	Year 2 student completing SSC2 project	Yr2 student	x		x	x	x	x	x					x	x			x	x	x	
UC03	Year 3 student on respiratory rotation (last of four)	Yr3 student	x	x		x	x	x			x	x		x	x		x				
UC04	Year 4 student at end of rotation	Yr4 student	x			x	x	x	x	x		x			x	x	x				x
UC05	Year 5 student preparing for their next rotation	Yr5 student	x	x		x	x	x	x	x	x	x			x		x			x	x
UC06	Student preparing to rejoin course after taking an intercalated year	Intercalated student	x	x		x	x														
UC07	Curriculum designer reviewing and reviewing a part of the course	Curriculum designer	x		x		x	x			x		x	x	x					x	x
UC08	Year secretary's morning tasks	Year secretary	x	x	x		x		x	x			x		x						
UC09	Assessment officer prepares for an exam board and its follow-up	Assessment officer	x	x					x	x			x					x			

UC10	College Office administrator's (COA) morning tasks	College officer	x	x	x				x				x		x						
UC11	Year 2 organiser (Y2O) preparing for new academic session	Year 2 Organiser	x	x	x	x	x		x	x	x			x	x		x	x	x		x
UC12	Year 4 SSC organiser (Y4SO) in run-up to SSC submission	Yr4 SSC Organiser	x	x					x			x			x				x	x	x
UC13	Year 1 module organiser (Y1MO) preparing week's work	Module organiser	x		x				x	x	x	x	x	x	x		x				x
UC14	Portfolio marker (PM) marks portfolio case reports	Portfolio marker	x						x						x						
UC15	External viva examiner (EVE) in run up to, and during exam week	External viva examiner	x				x		x	x					x						x
UC16	MTO Member (MTOM) working on information normalisation and objective-mapping in EEMeC	MTO Staff member	x	x			x		x	x	x	x	x	x	x						x
UC17	Guest user has a look around EEMeC	Guest	x				x								x						
UC18	EEMeC developer morning tasks	Developer	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
UC19	MBChB graduate checks course and accesses old materials	Graduate	x			x	x	x	x	x										x	
UC20	Medical liaison librarian updates evidence-based medicine (EBM) teaching pages	Medical Liaison Librarian	x				x				x			x	x	x	x				x

6.3: Evaluating VLEs: "What does it do?"

Returning to Umpleby's themes, having addressed what EEMeC can do in the use case scenarios, the next stage was to turn to what EEMeC actually does. To answer this question the use case scenarios presented in section 6.2 needed to be validated by real users as to how well they represented their actual experiences of using the system in their everyday working lives. The validation process had two steps. Firstly EEMeC developers (three individuals other than the author) were asked to validate the use case scenarios as part of the original authoring process and minor changes were made as a result. The cases were then sent to individuals in the community who were identified as representing the user in each use case. The instructions to validators are shown in table 6.3 and the contact list with the responses is shown in table 6.4.

EEMeC Use Case Scenario Validation

As part of our research and development work into EEMeC we have prepared a number of 'use case scenarios'. A use case is a hypothecated scenario that describes how a user interacts with a system. In particular it is intended to illustrate the different tasks that that user may complete and is intended to provide a fairly naturalistic representation of those tasks.

We are now seeking to validate these use cases by asking real EEMeC users to feedback and comment on the scenarios and relate them to their own activities with EEMeC. To that end we would like you to read the following use case and comment on the following aspects (as fully or briefly as you see fit and either as separate comments or as tracked annotations on an electronic or print copy):

1) How well does this use case represent the ways in which you work with EEMeC?
2) In what ways is it different and in what ways the same as your experiences?
3) What would you add or change to make it more realistic?

Table 6.3: EEMeC Use Case Scenario validation instructions.

Feedback was given in two forms. Where a use case was annotated and amended the use case itself has been altered to reflect the changes. Where comments were about a specific case but were generalised about the case as a whole they were entered in as validation notes under the use case in question. Where comments were about a number of use cases or the process in general these were also recorded in table 6.4. The number of responses for the validation was not particularly high. For the staff cases this still represented a majority of those asked for comments while for the students there was only a 5% return to the requests for feedback. Nevertheless the feedback at most only qualified the use case scenarios and the overall feedback was a general agreement and recognition of their experiences reflected in the scenarios given.

The core set of 20 EEMeC use case scenarios are presented in full in appendix 6.1.

6.4: Analysis

Having established an evidence basis for a cybernetic evaluation of EEMeC, the data needs to be analysed. This section will consider each factor (collated in table 6.1) and the use case scenario evidence relevant to it, discussing EEMeC both in terms of the use case scenarios and interpretation based on the author's direct experiences in working with EEMeC.

6.4.1: Implicit control and feedback in EEMeC

The UCSs cover both the use of immediately available information and resources and the pursuit of those that are not immediately apparent. For instance students access their 'My EEMeC' pages regularly and they also seek out information and learning resources relevant to their current studies.

The UCSs also cover the ways in which users manipulate these resources and what control they have over them. Access is observed to follow fairly traditional educational patterns in that staff control and provide access to information while students make use of what is available and what they are directed to use. Student autonomy is somewhat changed from its offline counterpart: students can access and interact with more of the course and do so much more often. At the same time they are tracked in much more detail meaning that their actions are now much more visible to others than they used to be. The UCSs also indicate the way EEMeC activities are grouped together as a result of the ways the system represents them and organises them for users. For instance the use of discussion and noticeboards are separated from each other despite both constituting asynchronous communication channels. The variety of UCSs also indicates the range of functions that different parts of EEMeC fulfil and the ways that they allow their users to interact and manipulate its tools and resources.

6.4.2: Explicit Control and Feedback: Cybernetic Functions of EEMeC

A number of UCSs, in particular those involving administrators, describe the use of passive tracking and active controls over activity as part of EEMeC. These cover the ability to check for submissions of coursework or logging attendance and the issuing of notices and instructions to return or submit information or to engage in certain activities. However, although the themes of passively recording activities, actively directing activities and actively requiring activities are covered in the UCSs, they miss some critical aspects of what actually takes place. Although the UCSs indicate many of the patterns of control and feedback in EEMeC, and the ways in which users comply with the operating parameters of the system, there are no dysfunctional use cases, no 'minority report'. In the absence of any negative, non-ideal or non-compliant cases the range and form of cybernetic controls and communications in EEMeC cannot be fully represented. As well as supporting compliant and constructive behaviours a system should also be able to protect and defend itself and its users against misuse, attack and other non-idealised forms of behaviour towards and within it. Before continuing it is therefore important that additional information on the security aspects of EEMeC is presented.

Table 6.4: EEMeC Use Case Scenario validation grid.

ID	Principle Case Actor	Responses	Comments and Results
UC01	Year 1 student	3	"I have read the three cases [1,2,6] and think that they are pretty close to how most users, including myself, go about using Eemec. However, I have found that I have never had any use for the annotation setting on Eemec and as such have never used it, this, I think is similar for most of my peers." [intercalating student] "1)How well does this use case represent the ways in which you work with EEMeC? Almost alike, though I hardly use the reminders programme to add personal events. 2)In what ways is it different and in what ways the same as your experiences? i use the timetable link everyday to check what i have for the day but do not print it out. i check all the short notices posted on too and also the discussion threads. however i have not experienced a exchange of immediate messages between me and another eemecer. 3)What would you add or change to make it more realistic? not all the lecture notes are on eemec. i am unsure whether this is eemec's problem or the lecturer's. maybe emoticons or coloured fonts can be added to make it more fun?" [year 1 student] "Genrally this case agrees pretty much with the way I interacted with Eemec last year and this year … As for Case UCO2 I havn't started my SSC2 project yet, so I don't feel qualified to comment." [year 2 student]
UC02	Year 2 student	1	
UC03	Year 3 student	0	
UC04	Year 4 student	0	
UC05	Year 5 student	0	
UC06	Intercalating student	1	
UC07	Curriculum designer	2	"I do not possess … knowledge of Eemec's structure and organisation, ditto for many of the terms used in the scenario i.e. a node, metadata, web front-end or database … [I] suggest modeling an real-life process to include editorial transactions (within and without Eemec), identifying exactly who might be involved and the parts they play … of course, nothing is perfect and you are always dependent upon the weakest link, which is always human. Perhaps we should not forget that" "I recognise what I read."
UC08	Year secretary	3	Use case includes notes made by the validators.
UC09	Assessment Officer	2	Use case reflects changes made by both validators.
UC10	College Office administrator's	1	Use case includes notes made by the validator.
UC11	Year 2 organiser	0	No response obtained.
UC12	Year 4 SSC organiser	1	Use case reflects changes made by the validator.
UC13	Year 1 module organiser	2	"I must say that I have never used EEMEC in such a coherent way; I tend to use it mainly to

			monitor discussion boards and I have never tried CAL with the medics (the scientists give me really positive feedback for the fact that I still teach with chalk and blackboard, which they seem to like: this is not a negative comment about CAL - both have their roles).”
UC14	Portfolio marker	2	Use case reflects changes made by both validators.
UC15	External viva examiner	2	Use case reflects changes made by both validators.
UC16	MTO Member	1	“I recognise what I read.”
UC17	Guest user	0	No validator available.
UC18	EEMeC developer	1	Use case reflects changes made by the validator.
UC19	MBChB graduate	0	No validator available.
UC20	Medical liaison librarian	1	Use case includes notes made by the validator.

6.4.3: Security and Control

Security and control are fundamental to any system, particularly technical systems and even more so one that exists on the Internet. Furthermore any successful system should be able to detect and where possible correct errant or misdirected activity. Some aspects of security and control were discussed previously in chapter five (table 5.5, point 1.2) but here this needs to be cast in terms of what users actually do. This section will review three types of EEMeC controls and go on to render three additional use case scenarios that capture the ways in which EEMeC users can take disruptive, errant or mistaken actions and the ways in which the system responds.

6.4.3.1: Technical Controls – Security and Direction

Technical security for a VLE can cover a wide range of issues across three broad areas;

- *Contextual security*: this includes the physical security of the VLE's server(s), their operating system security, their network security and security other aspects of the VLE's operating environment. EEMeC runs on servers administered by the system developers and to which only system developers have access. The operating system is constantly finessed to minimise security risk and network scans performed to check for network vulnerabilities. Until recently the physical location of the servers has been less than ideal with no specific server room locks or other security; the servers have been sitting in a loft of the suite of offices occupied by the developers and their colleagues. A recent change in accommodation has facilitated the setting up of a dedicated and secured server room.
- *Application security*: this includes all VLE application-specific security controls against attack, damage, unwanted access and accountability. Some of the ways in which EEMeC accommodates this are:
    - Standard security include scripts on every page check for data keys called 'cookies' which have been previously set on the user browser and which represent individual user permissions set for instance at login. If these are absent then the user is redirected to a page telling them they have been refused access and giving them the option to login.
    - Individual logins for every user ensure individual users are known to the system and can be tracked and held accountable for their actions within the system. This data is used for monitoring logins (this is the same data as was used in chapter four) and in particular tracking the authorship of discussion board messages.
    - An extensible range of user types can, for instance, quickly identify students by year (or special status such as intercalated) or more commonly identify staff as having additional rights to access this or that particular tool or area in EEMeC.

- Secure sockets layer (SSL) certificate-based encryption means that essential data such as passwords can be sent securely and in a format unreadable to any third party.

- *Application directions*: this includes all the ways in which the system configures its controls in an actively supportive fashion. For EEMeC these include:
  - Validation of the many forms with which users send data to EEMeC help users to complete these forms appropriately and accurately. For instance a form will show an alert if a particular field is omitted or has an unexpected data format within it.
  - Contextual help is available for certain areas of EEMeC. This provides specific support and use information for the page or function currently in use.

6.4.3.2: Social Controls – Rules and Laws

In addition to the technical aspects of control in VLEs there are a range of social controls. The importance and relevance of these is well summed up thus:

> *"there are no technical solutions for social problems. Laws are vital for security" (Schneier, 2004, p391)*

There are a number of laws and rules that place social controls upon a VLE's users:

- *Formal institutional:* these are the proximal rules and laws that the VLE's users work within. For EEMeC these include:
  - The conditions of matriculation for students or conditions of employment for University staff are the basis of the individual's rights and responsibilities in the University context. EEMeC, as a VLE in an undergraduate medical context, also supports many NHS staff who have no contractual relationship with the University.
  - The Edinburgh University Computing Regulations outline specific rules for providing and using University computing facilities. EEMeC is set up so that the first time any user logs in to EEMeC they are presented with these regulations and asked to agree to bide by them before being allowed to continue.
  - The Code of Conduct for Edinburgh Medical Students is a set of rules and procedures that outline how they should behave, particularly in clinical settings.
- *Formal legal:* these are the distal rules and laws that the VLE's users work within. For EEMeC (and other VLEs in the UK at least) these include:
  - The UK Data Protection Act (1998) provides individuals with a set of rights and responsibilities regarding the acquisition, storage and processing of personal information. EEMeC observes data protection principles by protecting data, by acquiring and processing

no more information than is necessary and by following its principles in spirit as well as in detail.

  - Legislation regarding human rights such as those that regard disability, race, and religion. Discrimination in EEMeC has never been raised as an issue but would be taken very seriously if it were. Supporting users with different potential disabilities provides challenges for VLE developers as a whole, although medical education requires all students at least to be fully physically and mentally able, thereby reducing the immediate need to provide for disabled users.

- *Informal:* these are the non-formal rules and norms that structure human societies. For VLEs these include 'netiquette':

  "the dos and don'ts of the cyberworld" (Hale, 1996, p75)

  For context-specific VLEs like EEMeC this also includes the norms of the particular networks and communities of practice in which the system is based.

6.4.3.3: Procedural Controls - Compliance

These are the specific procedural controls that are enacted in the VLE's context of use to enforce and maintain the rules and regulations on a day-to-day basis. In EEMeC these include:

- The discussion boards are not mediated; students can post without having their messages seen and approved by a member of staff. Along with this freedom, students are also given the responsibility to report messages that they find inappropriate. When this happens an email is sent to the EEMeC team manager and the senior MBChB administrator. This administrator checks the message and if it is inappropriate the EEMeC team is contacted to remove the message (or sometimes the entire thread) and the student summoned to a meeting with their Director of Studies, Director of Student Affairs and the administrator. If the alert is considered to have been aggravated then the student who made the alert may be called to account for their action.
- Unusual login patterns are checked for regularly. These would take the form of particularly large numbers of logins or simultaneous logins from different occasions. These would be taken as evidence that different users, either with or without the user's knowledge, were using a their account. In this situation the password is changed and the student queried as to whether they can account for the discrepancy.
- Whenever a script in EEMeC malfunctions an error generation script runs sending a copy of the debugging message to the EEMeC development team. Although this is mostly used in support of system development and for tracking and fixing system errors, it also alerts the developers to certain forms of inappropriate use. Examples include when users try to alter URLs to get access

to information that the system isn't giving them normally or when a user tries to get access to certain areas in the system to which they have no rights.

6.4.3.4: 'Edge-case' Scenarios

Having reviewed the ways in which EEMeC and its users exercise controls over their users it is clear that there are dysfunctional situations that need to be captured in the same way as the every day functional scenarios already developed. These kinds of scenarios have been identified as 'edge-case scenarios', infrequent and non-core situations which still need to be accommodated within a system specification (Cooper, 2004, pp180-181)

Three further use case scenarios were developed to augment the existing scenarios with a similar pattern of cross correlation between functions, different user types and activities to that used in table 6.2. This is shown in table 6.5. The additional use case scenarios are shown in appendix 6.2.

ID	Case Title	Discussion alerts	Error messages	Notice checking	Portfolio	Forbidden Access	Validation	Account suspension
UC21	Errant and Failing Student	x	x	x	x			x
UC22	Confused lecturer		x			x	x	
UC23	Module secretary		x		x		x	

Table 6.5: EEMeC Use Case Scenario design grid for 'edge-case' scenarios.

6.4.4: Explicit Control and Feedback: EEMeC as Cybernetic Medium

Returning to the cybernetic evaluation framework, the UCSs provide many examples of the ways that EEMeC acts as a cybernetic medium. This includes the ways that tutors prepare and employ online tutorial and lecture materials, the ways in which students discuss course business and study problems and thereby support each other via the discussion boards, and the ways in which pastoral aspects of the course are also covered. The portfolio marker and the external examiner both use EEMeC as a medium for explicit control and feedback and indeed all of the UCSs show aspects of control. Any computer system is intrinsically a cybernetic medium as it is engineered with specific functions that in turn permit certain ways of working and interacting with it. In this respect EEMeC is no different from any other computer system.

6.4.5: EEMeC and Holographic Design

- *6.4.5.1: "Build the 'whole' in to the 'parts'"*

  The use case scenarios (UCSs) relate the many ways in which EEMeC supports networks of activity and the ways in which it encourages and develops local skills and knowledge. Users engage in many networks of activity via EEMeC, reified in the ways they interact with each other, either asynchronously through the information and other resources in the system (noticeboards, discussion boards, portfolio marking, timetables) or synchronously through direct interactions (exam boards, EEMeC help desk, CAL packages and videos). It is also evident from the UCSs that networks of activity are often only partly mediated by EEMeC as there is still a lot of face-to-face interaction as well as a degree of email and telephone communication in these networks. Local skills and knowledge are also developed and enhanced in EEMeC as users have many controls over how they use the system and many users can affect the system state by adding, augmenting or editing the information and resources it contains. The EEMeC development team is clearly identified as a principle nexus of the system as they are the only ones with complete access to and control over the system. As the developers are part of the local activity environment this shows the degree to which EEMeC has retained local expertise and knowledge although it also indicates that there are different degrees of access and knowledge retention across the community. The UCSs are limited however in that they do not have a longitudinal aspect; they only constitute accounts of single instances. They fail to provide evidence of EEMeC's ability to retain its values and purpose over time.

- *6.4.5.2: "The importance of redundancy"*

  The absence of longitudinal data in the UCSs is also a problem in evaluating EEMeC's ability to adapt and innovate over time. The UCSs do indicate however how the system state may be added to or changed in other ways by different users and the ways different users may work on the same set of activities over time. This is shown in the ways staff edit and add content and the way students add discussion posts and submit coursework.

- *6.4.5.3: "Requisite variety"*

  The UCSs capture some of the complexity and range of user activities within EEMeC and the extent to which it encompasses much of what is done in the pursuit of everyday activity in the programme. What is absent from the UCSs (and accurately absent from EEMeC) is the face-to-face teaching and learning that takes place (and which still represents the core business of the MBChB) and the many other offline interactions that are part of the participants' every day lives. Some of the UCS validators indicated that they do not use one or another specific function but on the whole EEMeC would appear to achieve requisite variety as it is neither too complex nor too simple for what its users need to do. This conclusion should be tempered however with the possibility that a EEMeC's users adapt to its affordances and become less questioning of it over time. This human adaptation to technologies has been described as:

  > *"people seem to distance themselves from a critical evaluation of the technologies in their lives as if [they] were inevitable forces of nature" (Nardi and O'Day, 1999)*

- *6.4.5.4: "Minimum specifications"*

  The UCSs do not report specifically on the rules and regulations that govern how users can interact with EEMeC. At best the actions reported in the UCSs are normal, everyday and permitted activities and at best reflect much of what can be done but not what cannot be done. This last point sheds light on another limitation of the use of UCSs; they report on what the user actually does do, generally omitting what they might want or intend to do.

- *6.4.5.5: "Learn to learn"*
  Aspects of single loop learning for students are reflected in feedback from tutors and peers, using online tutorials, receiving portfolio and exam results and responding to noticeboard posts. Single loop learning for staff is demonstrated in their use of EEMeC as a knowledgebase of what happens in different parts of the MBChB programme. Aspects of double loop learning are reflected in the quality assurance processes supported by online evaluation, curriculum review informed by input from student discussions and the participative and collaborative nature of EEMeC's development.

The application of use case scenarios to tackle the evaluation of EEMeC in terms of its holographic design qualities has proved to be somewhat limited, particularly as they are representations of single instances or occasions, creating narratives that do not reflect the cognitive state of the user nor any more than their immediate intents and actions. However these issues are considered elsewhere in this thesis within the context of other metaphorical domain analyses covered in other chapters.

6.5: Discussion

Morgan identifies the weaknesses of the 'brain' metaphor as being self-referential and omitting power factors with respect to controls in a system. This has been borne out in the evaluation and analysis of EEMeC along cybernetic and holographic lines. In particular the evaluation of EEMeC's holographic design proved problematic because, although it is a cybernetic approach derived from Morgan's intended use of the brain metaphor, when put to actual use it crosses over into other metaphorical domains, in particular 'flux and change', 'psychic prisons' and 'politics and domination'.

Employing use case scenarios in support of a cybernetic evaluation of a VLE proved a useful and illuminating way to approach the problem but one that was not without its problems:

- The UCSs only represent a single event or a short temporal sample of activity. There is no representation of use over time and therefore no means to track change and effects such as adaptation (or its absence).
- the UCSs do not discriminate well between opportunity and actuality. By recording actual activity they do not indicate what other possible ways of acting and interacting might be possible or desirable.
- UCS useful but not with all aspects of a cybernetic analysis as they proved to be particularly weak when used to reflect on the holographic design criteria.

- Students tend to have fairly similar patterns of use and experiences whereas staff experiences are highly contextualised by their roles and rights within the system. Therefore the bulk of users (students and generic staff) are accommodated in a few cases while others sometimes only cover one or two individuals' experiences - validation in this situation is difficult and entirely dependent on extracting a response from often over taxed individuals.
- Additional use case scenarios that portrayed different negative user experiences were needed to get a more complete picture of the way the system works. This is an extension to the normal use of idealised use case scenarios for prospective system development.

The benefits include:

- Each UCS is a mini case study and therefore contributes a grounded triangulation point to the overall evaluation.
- Being cast from the perspective of a single user and being rendered in natural language enabled the UCSs to be relatively easily validated by representative 'real' users.
- The UCSs were able to support most of the areas of cybernetic evaluation identified although additional dysfunctional scenarios needed to be added to acquire a representative set. Only with positive and negative scenarios can a reasonably comprehensive set of cybernetic observations be undertaken.

Alternative methods and approaches might have included setting the cybernetic factors as questions and collecting data in response to each or pursuing the simple approach set out by Britain and Liber. Another might have been to use aspects of 'network analysis' (Lazega, 1997). Although this is more about topology than substance of interaction it could perhaps be an avenue for further development as a counterpoint to UCS approaches. Overall the development, validation and analysis of use case scenarios has proved generally effective and has done so in a way that allowed some degree of validation and has created a rich data set that can be reused in a number of other settings both within the overall research framework of thesis and beyond.

Chapter 7: VLEs as Cultures

7.1: Cultures

> *"culture is the link between human beings and the means they have of interacting with others" (Hall, 1959, p183)*

For Morgan the 'culture' metaphor is about regarding organizations as culturally constructed entities in dynamic relationships with their socio-cultural settings (Morgan, 1997). In terms of VLEs, the cultures of their development and use contexts may indeed be expected to have determining influence on how they are structured and how they are used. But if that is so then how might these influences be identified and measured? This chapter will explore aspects of culture with respect to VLEs and will present a substantive evaluation of EEMeC based on theories of 'communities of practice'.

This is a difficult metaphor to operationalise as there are a very great number of different ways of looking at cultures. The two methods used in this chapter are firstly to develop an ideographic account of the cultural contexts within which EEMeC is situated, and secondly to use Etienne Wenger's theories of 'communities of practice' (Wenger, 1998) to create an evaluation framework that looks at how well EEMeC meets the needs of its cultural context of use.

7.1.1: Theories of Culture

There have been many theories of culture. For instance Hall identified ten 'primary message systems' as constants around which every culture forms its values; interaction, association, subsistence, bisexuality, territoriality, temporality, learning, play, defence and exploitation (Hall, 1959). He also identified cultures as having formal, informal and technical emotional dimensions (Hall, 1959). In later work Hall added to his theories by differentiating between low context and high context cultures (Hall, 1976). In high context cultures information is embedded in the context and communication is heavily culturally contextualised (such as between long standing acquaintances); in low context cultures information is explicit and does not require contextualisation to acquire meaning (such as in a technical manual). As an illustration, within medical education, the scientists and the clinicians form two relatively distinct academic cultures; this could in part be explained as biomedical sciences tending to have a lower context culture relative to that of clinical sciences.

Describing the differences between cultures in an international context Trompenaars and Hampden-Turner differentiate between levels of culture; national (or regional), corporate and professional (Trompenaars and Hampden-Turner, 1997). More directly they identify a number of characteristics of cultures, modelled as the ways in which they respond to problems or dilemmas about people, time and the environment (ibid p8-10).

Although these approaches provide psychological, sociological and attitudinal ways of looking at and modelling cultures, on their own they do not constitute a structured way of looking at VLEs. So what are the cultural aspects of VLEs that can contribute meaningfully to their evaluation?

7.1.2: VLEs and Cultures

There are potentially two forms of cultural context that apply to VLEs; the cultures they sit within and the cultures they may contain. In general a VLE will be used within a number of overlapping and encompassing cultural contexts including regional (for EEMeC Scottish, British, European), sectoral (tertiary education), domain (undergraduate), and subject (medicine).

More directly, as a distinct entity, a VLE may have its own internal cultures, manifested by particular language, practice, attitudes and values shared by its users. However, a VLE rarely constitutes the primary activity of its users (as opposed to student learning for instance) nor is it separate from a course context (except perhaps in some particularly dysfunctional form) then it is more realistic to identify it in relation to its cultural context(s) of use. The relationship between a VLE and its cultural context of use echoes the importance of the VLE-in-use theme that has been recurrent through this thesis.

The next section will describe the cultural contexts for EEMeC. Before moving on it is important to introduce one further concept of culture; that based around shared practice. Cultures based on practice may fall into two kinds:

- Networks of Practice (NOP) – *"people in such networks have practice and knowledge in common. Nevertheless, most of the members are unknown to one another" (Brown and Duguid, 2000, p141)*. Examples would include general professional communities such as doctors or teachers, and other groups such as medical students in different schools or technology developers. An important aspect of a network of practice is that it is not limited in size, either in terms of participants or geographical spread.

Communities of Practice (COP) (Lave and Wenger, 1991; Wenger, 1998) are similar to networks of practice with they key difference that participants are known to each other and therefore engaging in negotiation, communication and coordination around their participation in the community. An important aspect is that a community of practice is inevitably limited by the practicalities of how many people can meaningfully interact as a coherent community.

7.2: Cultural Differences Within and Between VLE Contexts

The cultural contexts that VLEs exist and function in may be grouped into three levels; distal, proximal and individual. Distal cultures are those that exist beyond the immediate context of use and include those of the parent organisation, the regional location and those that pertain to networks of practice (NOP). Proximal cultures are those of the immediate context of use and include the specific instances of its different communities of practice (COP) as well as other context-specific factors. Individual cultures are those of the individuals that participate in the proximal communities of practice but which are not part of the proximal cultural mix, in other words their individual cultural backgrounds and influences.

7.2.1: Distal Cultural Dimensions of EEMeC

EEMeC supports the MBChB undergraduate medicine course at the University of Edinburgh. As such it has (as with any similar degree programme) distal cultural influences from its host institution, its regional setting and its constituent networks of practice:

- Institutional: the University of Edinburgh is the largest higher education institution in Scotland with 16,172 undergraduate and 5,462 postgraduate students and “28.6% of Scotland’s total research income” (The University of Edinburgh, 2004). The predominant culture in the University is scholarly, academically independent and moderately conservative. Its devolved nature and the sheer size of the institution often means that loyalties tend to lie at the department or school level rather than to the University as a whole. Because of the close relationship with hospitals and clinics required by medical education there are also cultural influences from bodies such as the National Health Service (NHS).
- Regional: higher education is managed separately in the four regions that make up the United Kingdom. Following devolution the differences between Scottish higher education and that in the rest of the UK have grown. This divergence between Scotland and England has led to tensions over competition and funding of student places both north and south of the border. Scottish medical education is relatively well interconnected, in particular through the Scottish Deans’ Medical Curriculum Group (SDMCG), which undertakes common development of activity and policy across all five medical schools (Aberdeen, Dundee, Edinburgh, Glasgow and St Andrews). The culture of undergraduate medical education in Scotland is fairly coherent, communitarian and forward thinking, responding as it does to common external pressures from the Scottish Higher Education Funding Council, the NHS and the General Medical Council.

- There are a number of networks of practice that inform the Edinburgh MBChB including medical, scientific, educational and technological:
    - Medical networks of practice are based on the practice of medicine in general and on practice within disciplines and specialisms. Professional bodies such as the various Royal Colleges and journals such as the British Medical Journal (BMJ) and The Lancet act as a strong cohesive force in this network of practice.
    - Scientific networks of practice are similar to those of medicine in that they are coherent at the level of science as a whole as well as at discipline and sub-discipline levels. However science appears to be a lot less communitarian than medicine, due in part to the need to compete for grants and other funding and in particular in the UK the need to perform in the Research Assessment Exercise (RAE).
    - Educational networks of practice are even less well established than those of science or medicine and this may in part reflect the lower priority attached to education in universities and colleges dominated by the RAE. However undergraduate medical education is atypical as it tends to be a coherent domain of practice as evidenced by having its own journals, conferences and distinct practices.
    - Technical networks of practice in the MBChB are less well defined than any of those previously described. This is part due to their relatively recent emergence, their diversity of activity and a lack of focus. The main way this network of practice interacts is through the exchange of questions and answers through the multitude of 'how to' and other support websites, and through extra-institutional learning technology activities such as those run by JISC or the Association for Learning Technology (ALT).

7.2.2: Proximal Cultural Dimensions of EEMeC

Within the Edinburgh MBChB there are a number of distinct cultural components:

- *Institutional cultures*: the University of Edinburgh is structured around three Colleges plus a range of central business and support services. The MBChB is one of the two main degree programmes offered by the College of Medicine and Veterinary Medicine (the other being undergraduate veterinary medicine). The Colleges have quite different dynamics (see section 5.4). The differences between the cultures of the Colleges is less however than the differences between the cultures of the largely academic Colleges and the business-focused central services of the university.
- *Location cultures*: the MBChB is run in many different locations across southeast Scotland. There are different cultural influences in these different locations. In particular this is due to

the range of primary activities in these locations. The culture of a central university teaching area can be very different to that of a GP practice or psychiatric hospital.

- Finally, and probably most importantly, there are cultures based around the *communities of practice* that participate in the MBChB programme:
  - Students are the principle subjects and focus of the MBChB. Student cultures are based on the shared negotiation of the transition from novitiate to graduate doctor. Medical students represent a relatively distinct culture from other students and have quite a degree of vertical contact between different year cohorts. The unparalleled extent to which undergraduates are exposed to disease, suffering and death as part of their studies and the amount of socialisation inherent in medical curricula also tends to set them apart from other student groups.
  - Biomedical scientists are responsible for much of the teaching at the start of the programme. Based around long-established disciplines such as anatomy, physiology, pathology and microbiology, the dominant culture is one of positivist research rather than teaching. Public health also has a large role in the earlier stages of the programme and although its practitioners tend to have a strong research focus their cultural outlook is also related to that of the social sciences.
  - Clinicians are responsible for much of the teaching in the later stages of the programme. Their primary role is providing clinical services to the NHS; many have only honorary University appointments while others have no formal contractual relationship with the University at all. Their dominant culture is therefore patient care and clinical practice and they may spend less than five percent of their time in teaching activities.
  - The practice of course administration and governance also constitutes a community of practice. In the MBChB these aspects are controlled by the College Office. In this respect the administrative and academic aspects of the course are run relatively autonomously of each other and there are resulting tensions between the strictly procedural outlook of the administrators and the highly exploratory and academic outlook of the teaching staff in the programme. The role of administrators is atypically large in medical education due to its complexity; it involves higher degrees of audit and accountability than other disciplines, it sits across university and NHS boundaries, and it raises all sorts of logistical issues as students are moved through their rotations, attachments and carousels.
  - Clerical staff primarily support the administrators and those teachers with administrative responsibilities. This group is a community of practice of secretaries and they support each other in this way. Interestingly it was an EEMeC meeting (to

discuss common templates for study guides) that first brought all of the year secretaries and a number of College Office secretaries together for the first time.

- Curriculum designers and managers also constitute a small but discrete community of practice consisting of clinicians, scientists and educational specialists whose role is to see that the curriculum is well designed, meets its objectives and requirements and provides a high quality experience for all concerned. In the MBChB this group is called the Medical Teaching Organisation (MTO). Medicine is fairly unusual in having such a concentrated effort in its curriculum management; it is more usual for there to be greater autonomy devolved to year and course organisers.
- Learning technologists are a relatively new presence in the Edinburgh MBChB. They have been an essential component in the development of EEMeC and they play an expanding role as EEMeC and other learning technology-based interventions are increasingly used throughout the programme. The culture of the Learning Technology Section, and in particular its e-Learning Unit is relatively informal in comparison with the rest of the MBChB and as its funding is largely tied to its ability to generate income it has needed to be entrepreneurial, which also sets it apart from the other cultures in the MBChB mix.

Although the MBChB has many different constituent communities of practice it can also be viewed as a single community of practice in its own right. This is the thesis of section 7.3 in this chapter.

7.2.3: Individual Cultural Dimensions of EEMeC

The individuals involved in the MBChB bring their different individual cultures with them. In no particular order these include aspects of: gender, sexuality, religion, education (in particular differences between private and state school pupils), nationality and regionality, race, socio-economic status and professional family background. These will all flavour an individual's participation in the MBChB and they will contribute to the overall social dynamics of the programme. This is often to be seen reified in EEMeC discussions that polarise along lines of gender or faith.

7.3: VLEs and Communities of Practice

Originally focusing on ideas of apprenticeship, the development of theories of communities of practice coalesced around the concepts of legitimate peripheral participation in a community of practice (Lave and Wenger, 1991):

> *"learners inevitably participate in communities of practitioners … mastery of knowledge and skill requires newcomers to move toward full participation in the sociocultural practices of a community" (ibid p29)*

The rest of this chapter describes the use of Wenger's theories to structure an evaluation of EEMeC's ability and suitability to support the MBChB expressed as a community of practice[1].

7.3.1: Wenger's Learning Architecture Framework

In 'Communities of Practice' (Wenger, 1998), it was argued that orthodox approaches to learning based on concepts of individuals learning in prescribed ways causally linked to teaching are redundant. Wenger proposed an alternative 'social theory of learning' based upon learning as individual engagement and participation in a community of practice.

Wenger's theories are particularly relevant in modelling learning environments where they encompass a pre-existing learning community of students informed by socio-cultural norms and values inherent in the practice and the related social contexts in which it is situated. The relevance of this model depends on the degree and coherence of shared purpose, meaning, activity and identity across the course community. For instance in modular arts or science programmes the model may be expected to be relatively weak as students pursue individual patterns of cross-disciplinary study while in an integrated vocational context such as law or teaching the model would be expected to be more relevant.

There are existing studies that have applied Wenger's theories in the context of VLEs (Rogers, 2000; Chalk, 2001). These have tended to take Wenger's general topics of 'mutual engagement', 'joint enterprise' and 'shared repertoire' as the basis for their work rather than anything more detailed. Their focus also tends to fall uneasily between the learners and their environment without clearly identifying one from the other. However, following his discussions of the general dynamics and characteristics of communities of practice, Wenger goes on to formalise these dynamics in his 'Learning Architecture Framework' (LAF) for a learning community of practice. This framework has the following defining characteristics or properties (Wenger, 1998, p237-239):

- Facilities of Engagement
- Mutuality – interactions, joint tasks, help, encounters across boundaries, degrees of belonging
- Competence – opportunities to develop and test competences, devise solutions, make decisions

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[1] NOTE: This work has been published separately: Ellaway, R., Dewhurst D., McLeod H. (2004). "Evaluating a virtual learning environment in the context of its community of practice." ALT-J 12(2): 125-145.

- Continuity – repositories, documentation, tracking, 'participative memory', storytelling, 'paradigmatic trajectories'
- Facilities of Imagination
- Orientation – location in space, time, meaning and power
- Reflection – models and patterns, opportunities for engaging with other practices or break rhythm with the community mainstream
- Exploration – trying things out, simulations, play
- Facilities of Alignment
- Convergence – common focus or cause, direction, vision, values, principles
- Coordination – procedures, plans, schedules, deadlines, communication channels, boundary encounters and brokers
- Jurisdiction – policies, contracts, rules, authority, arbitration, mediation

Accepting these as key properties of a learning community of practice, this framework can be used as the basis of a more structured evaluation methodology, evaluating a VLE in its context of use. It is proposed that by using this framework a VLE can be evaluated in terms of its success and value in supporting these nine properties in the context of the community of practice that employs it.

This is an inherently faceted approach; the nine-point LAF has no inherent hierarchy or ranking of importance or relevance. These can only be judged or evaluated in the context at hand. Indeed, any given course context may well contain distinct constituent communities of practice (such as staff or students) that themselves hold contrasting and conflicting perspectives and value systems within the broader course community of practice. This approach depends on the following assumptions: that Wenger's theories adequately model a community of practice; that the subject area or discipline has a strong identity as a community of practice; and that the community of practice encompasses the whole course. This approach does not seek to test theories of communities of practice. Rather it assumes a pre-existing course community of practice as a given reference point and thereby evaluates a VLE by its ability to support that course community of practice. A note of caution should be introduced at this point. The approach advocated in this paper is a descriptive post-hoc evaluation model and is not intended as a template for designing a VLE. As Schwen and Hara observe:

> *"while Wenger's work is a provocative ideal to achieve and useful as a dialogue between the designers and client systems, it is not a recipe for construction of such phenomena" (Schwen and Hara, 2003, p262)*

It should also be stressed that the use of the LAF is intended for use where a VLE is part of a blended learning environment. Some approaches that draw upon the principles of communities of practice are predicated on the community of practice being either fully or predominantly online (Notess and

Plaskoff, 2004). It is more usual in higher education however for a VLE to provide scaffolding and support within a multi-modal environment (Ellaway, Dewhurst et al., 2003).

7.3.2: Method: developing a VLE evaluation tool based on the LAF

The first stage of the development process was to move from the general component factors of the LAF to increasingly specific questions aimed at evaluating VLEs. The first three steps of this process are shown in table 7.2 and were at this stage fully derived from Wenger. The second stage was to extend Wenger's theories to develop a pool of VLE-oriented questions based on the 'specific aspects' column of table 7.2. This pool of questions was piloted with a variety of members of the target learning community and, as a result, a number of questions were combined, rephrased or omitted. A particular outcome of this piloting was the development of a three-stem structure for each question, based on general effectiveness, personal utility and personal value. The questions were then rephrased as value statements and response options were structured against Likert scales. Rather than creating new scales, the Likert scales were selected from those available in the online evaluation system (in EEMeC) that was to be used in delivering the instrument. The instrument was piloted again and further refinements and adjustments made.

General factors	**General questions**	**Specific Aspects**
Mutuality	Does/will the system support and facilitate the required mutuality and how important is this?	Interaction
		Joint tasks
		Peripherality
Competence	Does/will the system support and facilitate the required competences and how important is this?	Initiative and knowledgeability
		Accountability
		Tools
Continuity	Does/will the system support and facilitate the required continuity and how important is this?	Reificative memory
		Participative memory
Orientation	Does/will the system support and facilitate the required orientation and how important is this?	Location in space
		Location in time
		Location in meaning
		Location in power
Reflection	Does/will the system support and facilitate the required reflection and how important is this?	Models and representations
		Comparisons
		Time off
Exploration	Does/will the system support and facilitate the required exploration and how important is this?	Scenarios
		Simulations
		Practicum
Convergence	Does/will the system support and	Focus, vision and values

	facilitate the required convergence and how important is this?	Leadership
Coordination	Does/will the system support and facilitate the required coordination and how important is this?	Standards and methods
		Communication
		Boundary facilities
		Feedback facilities
Jurisdiction	Does/will the system support and facilitate the required jurisdiction and how important is this?	Policies, mediation, arbitration and authority

Table 7.2: developing Wenger's Learning Architecture into an evaluation instrument (after Wenger, 1998, p237-239). The process started in the left column with Wenger's LAF factors, structured them as general questions/principles for a VLE and worked them into specific aspects/questions for each general question.

The resulting evaluation instrument comprised of 60 items (see appendix 7.1). The instrument was designed to be administered to all of the VLE's users, irrespective of their role in the learning community.

7.3.3: Using the LAF evaluation instrument

The survey instrument was deployed using EEMeC's own 'evaluation engine' which allows staff to create, schedule, deliver, record and analyse questionnaires online (Wylde, Ellaway et al., 2003). Different (identical) copies of the LAF instrument were set up for the different groups that would receive them. Although a log of who had completed questionnaires was kept, this was separated from the responses so that they were anonymised at the point of storage. The online system was designed to permit just one response per individual.

The period set for delivery was from 10 April to 30 April 2003, a period that mapped on to different years based on their term or rotation schedule as follows:

- Year 1 – on vacation to 15th April then starting term 3
- Year 2 – on vacation to 15th April then starting term 3
- Year 3 – new clinical rotation started 10th April
- Year 4 – in middle of clinical rotation (24/2 to 30/5)
- Year 5 – in middle of clinical rotation (31/3 to 23/5)

The response rates (shown in detail in table 7.4) were high overall (median = 77.5%) although the staff responses were particularly low. The figure of 699 staff includes 50 or so guest logins and a large number of clinical and related staff who have a relatively peripheral engagement with the course. It is a peculiarity of medical education that a large number of clinical staff will be involved in teaching but only for a fraction of the working year. Thus, despite the high potential numbers of staff in the course, at any given time only a relatively small number are actively engaged in teaching, explaining the relatively poor responses in the staff cohort. It is important to note that this was the first time that staff had been surveyed in this fashion.

Course role	Population	Returns	% returns
Year 1 students	236	207	87
Year 2 students	214	186	87
Year 3 students	258	142	55
Year 4 students	221	192	87
Year 5 students	176	120	68
All staff	699	45	6

Table 7.4: responses for all cohorts for the EEMeC LAF evaluation

There is a lower response rate in year 3 with only just over half of the year responding relative to that in year 4. This can be interpreted as being due to year 3 students focusing on orienting themselves within their new clinical attachments and not engaging with EEMeC to a great extent while year 4 and 5 students, already established in their attachments, were using EEMeC regularly.

	% returns	% complete returns	% incomplete returns
Year 1	87	81	6
Year 2	87	79	8
Year 3	55	50	5
Year 4	87	73	14
Year 5	68	56	12
staff	6	6	0

Table 7.5: number of responses and completion rate for all cohorts for the EEMeC LAF evaluation

7.3.3.1: Errors and Completeness

The survey was the first to have more than 40 questions that used the EEMeC delivery system. This particular survey was not trialled ‘live’ on the system beforehand as it is permanently active. A problem arose when processing questions from 41 upwards. This meant that a number of questionnaire responses were truncated to the first 40 responses, losing responses 41-60. The scale of the returns affected is shown in table 7.5. The overall proportion of the sample affected by truncated returns is 10.3%. There is however no way to discriminate between a technical truncation error and a student simply failing to complete a complete set of responses.

The trend for non-completion can be analysed. The following graph shows the number of completed questions per return. There is a general trend for non-completion with only about 39% of the response sets complete, while 91% of the response sets had 40 or more complete responses. The effect of the technical problem can be identified as the plateau or shear at the 66% completed questions mark. This constitutes 6.9% of the response sets affected. Overall the amount of data lost in an incomplete response set was not considered to warrant the removal of the whole response set.

Where users had submitted an entire questionnaire return without completing more than one question these whole response sets were removed as listwise deletions. There were 72 such response sets, which amounted to 8% of the responses received (72/894).

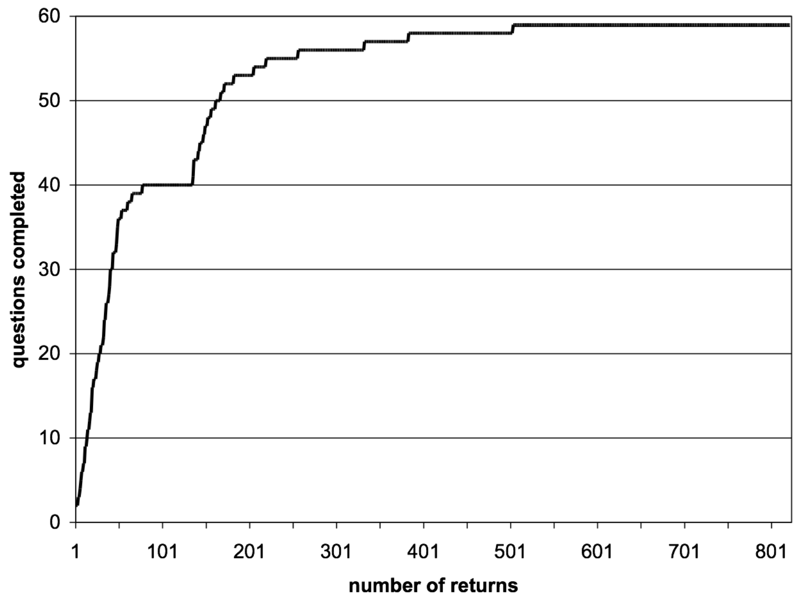

Figure 7.1: number of response sets indicating rate of completion of all 60 questions for the EEMeC LAF evaluation

7.3.3.2: Accuracy

By using an online system that is already familiar to the students, there was a large degree of control maintained over the accuracy of the data collection and storage. There were however two problem areas:

- The returns for year 4 cohort A show more returns than there are in the group. As was mentioned earlier, a data processing problem arose which led to about 7% of the responses being truncated. The truncation also resulted in a questionnaire remaining active even after completion. Although there was no more than a 24-hour period during which this was the case, for year 4 students, who were most active in the course at that stage, this led to a number of resubmissions. The degree of duplication is hard to quantify due to the anonymisation of the response set although for Y4_A it is estimated to be ~10%.

- One return in year 4 cohort C was corrupt with the inputs out of sequence. Re-sorting the inputs cleaned this up

7.3.3.3: Uniformity

The instrument was delivered online via EEMeC and was thus uniformly presented to the study group and data uniformly returned and represented.

7.3.3.4: Data 'Cleaning' and Coding

The online questionnaire returns 'x' when the item has not been selected and the form is submitted because the default value for the 'please select …' form element is 'x'. These were treated as null values and were therefore pairwise deletions. The 'not applicable' option was also treated as a null value and instances of this were also therefore pairwise deletions. Question 60 was a free text answer and these responses were handled separately. The remaining three question types were structured against 4-point Likert scales which were coded as shown in table 7.6.

Question Type 1 Responses	Question Type 2 Responses	Question Type 3 Responses	Coded Ordinal Value
Strongly agree	Excellent	All the time	4
Agree	Good	Often	3
Disagree	Poor	Seldom	2
Strongly disagree	Awful	Never	1

Table 7.6: ordinal coding structures for Likert responses.

7.3.4: Analysis and Interpretation

7.3.4.1: Triad analysis (effectiveness/utility/importance)

Questions 1-54 were delivered in triads framing the same question in terms of general effectiveness, personal utility and personal importance. A mean for each respondent for each of the three stem variants was taken. This was then analysed for internal reliability by calculating a Cronbach's alpha reliability coefficient, which showed a high degree of internal reliability (alpha = 0.8652). Non-parametric correlation analysis (Spearman's rho) was then carried out between each of the three pairings (respondent means). There was a significant positive correlation between general effectiveness and personal utility (rho=0.914, n=821, $p<0.0005$). This indicates that there are fairly balanced feelings as regards EEMeC; respondents did not rate EEMeC as particularly good or bad in general relative to EEMeC's usefulness to them. Analysis of this correlation would be expected to indicate whether a VLE had a particular subjective reputation-bias relative to its objective evaluation.

For EEMeC effectiveness and utility were seen as equivalent by the respondents. There was also a significant positive correlation between general effectiveness and personal importance (rho=0.429, n=818, p<0.0005) and a significant positive correlation between personal utility and personal importance (rho=0.448, n=818, p<0.0005). Respondents considered EEMeC's importance was less than its perceived effectiveness or utility. These pairings indicate the degree to which the VLE is the medium for course business. Positive correlations would indicate that the VLE was a major medium for the course, no correlation that the VLE was no more or less important than other media and negative correlations that the VLE was of little or no relevance to the course. The result shows EEMeC is a significant medium for course business but not the largest or most important one.

7.3.5: LAF Validation

Since the questions had originally been generated from the LAF, it was important to verify that the predicted mapping between questions and the LAF was statistically valid. Factor analysis and inter-item reliability and correlation tests were performed - see table 7.5. An inter-item test of reliability (Cronbach's alpha) was performed for each set of mapped responses to the LAF (as shown in table 7.6). This was performed on the personal utility component of each triad (the previous section displayed that there was a very high correlation between effectiveness and utility and a reasonably high correlation between utility and importance). A non-parametric correlation analysis (Spearman's rho) was also carried out for all item pairs. There was no significant difference between the mean correlation for the LAF mappings and the overall mean correlation. This indicates that, although a reasonable level of reliability has been established, the overall mapping is not very strong and further work needs to be done to refine this part of the instrument. Such work would require a VLE that was much less successful and popular than EEMeC to give a broader spread of positive and negative.

Factor	Rotation Sums of Squared Loadings			Interpreted factor description
	Total	% of Variance	Cumulative %	
1	9.296	15.756	15.756	Personal Importance and relevance
2	3.875	6.567	22.323	General course participation
3	3.781	6.409	28.732	External connectivity
4	3.589	6.083	34.816	Support of activities
5	3.380	5.729	40.544	Educational support
6	3.109	5.270	45.814	Personal logistics
7	2.204	3.735	49.549	Feedback
8	2.187	3.707	53.256	Authority
9	1.978	3.352	56.608	Tracking and protection
10	1.906	3.230	59.838	Communication
11	1.887	3.199	63.037	Assessment

12	1.848	3.132	66.169	Provision of Information
13	1.720	2.915	69.084	General support

Table 7.5: factor analysis and interpretations (extraction method: principal component analysis, rotation method: varimax with Kaiser normalization). The factor analysis identified thirteen underlying significant factors with the dominant factor being 'personal importance' Although there was some congruence between the two, there is no strong equivalence between this analysis and the LAF map. However, as the responses were overall very positive and therefore heavily negatively skewed, there was a low level of variance and therefore a factor analysis might not be expected to be particularly illuminative.

Question triad	Mutuality	Competence	Continuity	Orientation	Reflection	Exploration	Convergence	Coordination	Jurisdiction
4, 5, 6	x	x	x					x	
7, 8, 9	x	x	x			x			
10, 11, 12		x	x	x			x	x	
13, 14, 15	x				x			x	
16, 17, 18		x		x				x	x
19,20, 21		x	x				x	x	x
22, 23, 24	x	x	x						
25, 26, 27			x	x			x		
28, 29, 30			x	x	x				
31, 32, 33			x	x	x				
34, 35, 36			x	x				x	
37, 38, 39		x		x		x			
40, 41, 42		x		x	x	x			
43, 44, 45			x	x			x	x	x
46, 47, 48	x	x					x	x	
49, 50, 51	x		x					x	
52, 53,54		x	x						x
reliability coefficient	0.886	0.917	0.926	0.920	0.838	0.818	0.876	0.914	0.823

Table 7.6: questionnaire-to-LAF map and inter-item reliability using Cronbach's inter-item alpha reliability coefficient. The results show a strong level of consistency across the question groups and therefore an acceptable level of reliability for the question-LAF map (none of the reliability coefficients were < 0.8).

7.3.6: Overall LAF analysis

Having established the question-LAF map, each factor was analysed for each respondent group. The results of this are shown in figure 7.1. In order to see the difference in factors more clearly means of the scores are taken across groups and factors ranked as shown in figure 7.2.

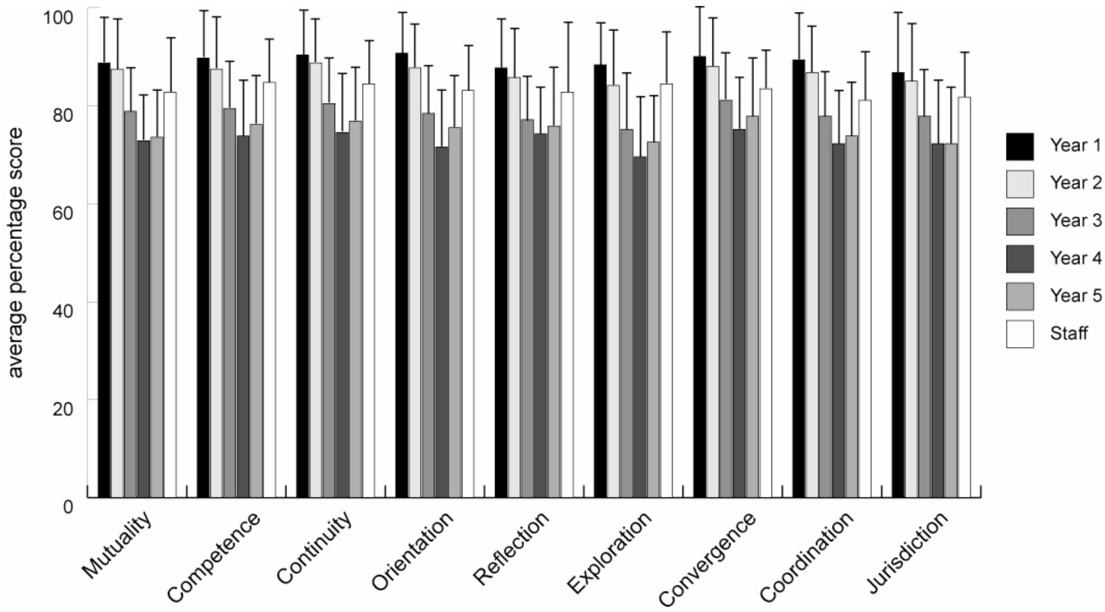

Figure 7.1: learning architecture framework scores for EEMeC. The results are fairly consistent across different groups. Year 1, 2 and staff views appear congruent as a sub group and years 3,4 and 5 as another sub group.

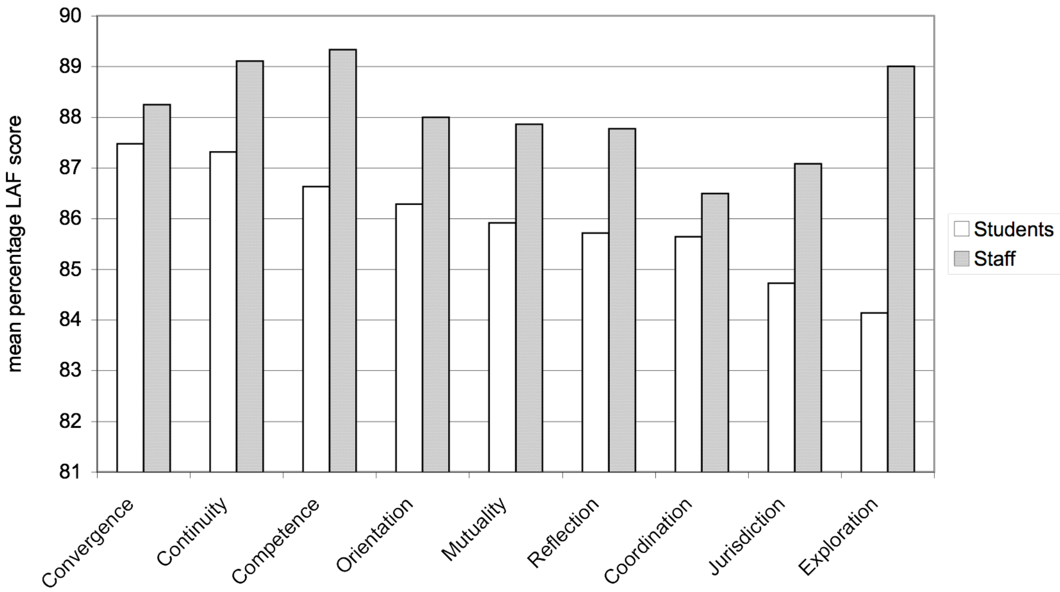

Figure 7.2: mean percentage learning architecture framework factor scores for EEMeC ranked for student responses. Staff consistently rate higher than students. There is reasonable congruence

between the staff and student ratings with the notable exception of 'exploration': staff rate EEMeC third highest for exploration while students rate it lowest of all.

7.3.7: Grouped Triad Analysis

Questions 1 to 54 consisted of triads of each evaluate in terms of general effectiveness, personal utility and personal importance. Note that 551 triads had one or more component missing out of 13687 triad responses (4%). SPSS was used to generate a non-parametric Spearman correlation analysis between the respondent means for each of the three stem variants as shown in table 7.7:

			General Effectiveness (GE)	Personal Utility (PU)	Personal Importance (PI)
Spearman's rho	GE	Correlation Coefficient	1.000	.914(**)	.429 (**)
		Sig. (2-tailed)	.	.000	.000
		N	821	821	818
	PU	Correlation Coefficient	.914(**)	1.000	.448(**)
		Sig. (2-tailed)	.000	.	.000
		N	821	821	818
	PI	Correlation Coefficient	.429(**)	.448(**)	1.000
		Sig. (2-tailed)	.000	.000	.
		N	818	818	818
** Correlation is significant at the .01 level (2-tailed).					

Table 7.7: correlation analysis for triad questions.

- GE-PU: there was a significant positive correlation between general effectiveness and personal utility (rho=0.914, n=821, p<0.0005, two-tailed).
- GE-PI: there was a significant positive correlation between general effectiveness and personal importance (rho=0.429, n=818, p<0.0005, two-tailed).
- PU-PI: there was a significant positive correlation between personal utility and personal importance (rho=0.448, n=818, p<0.0005, two-tailed).

From this the following can be interpreted:

- The significant positive correlation between general effectiveness and personal utility (rho=0.914) is particularly high. Respondents had very similar ratings for general effectiveness and personal utility for EEMeC. This indicates that there are fairly balanced feelings as regards EEMeC; respondents did not rate EEMeC as particularly good or bad in general relative to EEMeC's utility for them personally. Analysis for this correlation would be expected to indicate whether a VLE had a particular subjective reputation-bias relative to objective evaluation.

- The correlation between general effectiveness and personal importance (rho=0.429) although both significant and positive is less than that for GE-PU. Respondents considered EEMeC's importance to them was less than its effectiveness in performing its tasks. This indicates the degree to which the VLE is the medium for course business. High positive correlations would be expected to indicate the VLE was the principal medium for the course, no correlation that the VLE was in an equable relationship with other media for the course and high negative correlations that the VLE was of little relevance of the course. A continuum of exclusive use/partial use/no use is indicated. In this situation the correlation indicates that EEMeC is considered to be a significant medium for course business but not the principal one.
- The correlation between personal utility and personal importance (rho=0.448) although both significant and positive is less than that for GE-PU but larger than that for GE-PI. Thus, although respondents considered personal importance of less significance than general effectiveness, there is a slightly higher correlation with personal utility. This is interpreted that the personal utility received was more important to respondents than the perceived general effectiveness of the EEMeC.

	Mean effectiveness	SD	Mean utility	SD	Mean importance	SD
Year 1	3.89	0.1	3.87	0.14	3.4	0.24
Year 2	3.78	0.21	3.8	0.22	3.38	0.24
Year 3	3.49	0.29	3.52	0.29	3.19	0.18
Year 4	3.35	0.36	3.34	0.32	2.96	0.18
Year 5	3.43	0.28	3.41	0.3	3.04	0.24
Staff	3.7	0.2	3.63	0.26	3.26	0.21

Table 7.8: overall effectiveness, utility and importance factors for EEMeC

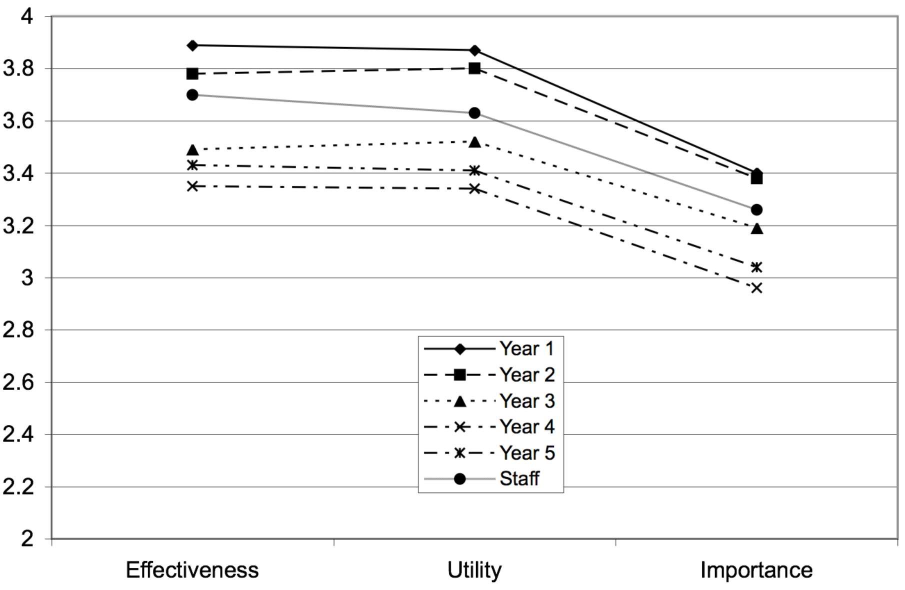

Figure 7.3: plot of mean effectiveness, utility and importance scores from all triads. The vertical scale goes from 0 to 4, the graph shows the top half of the scale only. The graph shows that all cohorts score effectiveness and utility well into the top quartile and at approximately the same level with importance, on mean, scoring 13% lower. Year 1 scores highest, then year 2, followed by staff, year 3, year 5 and lastly year 4. Years 1, 2 and 3 score utility slightly higher than effectiveness while years 4 and 5, and particularly staff, score it lower. This can be interpreted as showing that EEMeC is considered to be very effective and useful by the MBChB community although not of prime importance due to the course not being predominantly delivered through EEMeC.

	Year 1	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Staff*
No substantive comment	4	7	3	2	0	1
Complaints about evaluation	5	13	15	23	9	4
Positive statement about EEMeC	8	12	8	11	5	2
Negative statement about EEMeC	2	3	5	13	4	0
Negative comment about staff	4	17	11	13	7	2
Suggestions for improvements	26	19	17	18	23	9
Population	*236*	*214*	*258*	*221*	*176*	*699*
Respondents	*207*	*186*	*142*	*192*	*120*	*45*
Free text responses	*40*	*61*	*45*	*35*	*37*	*16*
% population	*16.95*	*28.50*	*17.44*	*15.84*	*21.02*	*2.29*
% respondents	*19.32*	*32.80*	*31.69*	*18.23*	*30.83*	*35.56*

Table 7.9: free-text question analysis. A response may contain several separately logged responses. The largest number of comments suggested improvements to EEMeC and indeed these have been passed to the MBChB quality assurance committee and to the EEMeC developers for consideration. The next largest number focused on negative comments about the evaluation both in particular and in general, the most common complaint being regarding the size of the instrument. Complaints were also numerous about how staff use EEMeC (i.e. they don't as much as students would like). The number of comments praising EEMeC was higher than that criticising EEMeC although it is important to note that in year 3 this trend was reversed.

7.3.8: Individual question triad analysis

Each of the question triads was then analysed across respondent groups and in comparison to the triad average and the overall average. A graph for each triad provides a useful illustration of the dynamics within the course community for each of the 18 issues addressed. Each of the triads was analysed across the groups and compared to the triad mean and the overall triad mean. These are shown in appendix 7.2. Returning to the EFFUTI profile, we can now look at the overall pattern across the community's cohorts as shown in table 7.8. Converting to percentage scores ((x-1)*33.3) this data can be plotted as shown in figure 7.3.

7.3.9: Free-text analysis

Question 60 was a free-text response allowing any other comments to be added. Around 28% of respondents provided input to this question (see table 7.9).

7.3.10: Issues of Bias

Before leaving the data analysis part of this section some accommodation of sources of bias and how they were accommodated (or otherwise) should be included:

- *Respondent fatigue*: There were a number of problems with the delivery of the questionnaire; these have already been discussed in section 7.3.3.1. These problems did however result in some reported frustration from student respondents. More importantly a number of students complained about the size, complexity and wording of the instrument and indicated that they gave less than focused answers as a result. It is therefore to be expected that respondent fatigue introduced a degree of 'noise' to the responses given.
- *Respondent group bias:* No accommodation has been made in the analysis for cohort bias as each academic year in the course has the approximately the same make up regarding gender, ethnicity etc and there is a significant mixing up between cohorts mid-course as about 40% of each cohort take a year out to do an intercalated honours course.
- *Delivery bias:* As the VLE was the medium for delivery of the questionnaire; it is reasonable to anticipate a degree of bias from the fact that EEMeC users were the only ones who could have responded. The fact that use of EEMeC is mandatory for a number of course activities and the high student response rates indicate a fairly comprehensive coverage of the overall population however.
- *Scheduling bias:* The questionnaire was sent out for the same two weeks independent of what each respondent cohort was doing. Years 1 and 2 were on vacation for the first of the two weeks, year 3 was just starting a new clinical rotation and years 4 and 5 were in the middle of

clinical rotations. It is possible, although not apparent from the available data, that the scheduling could have introduced bias in the responses given.

7.3.11: Reusing the LAF Instrument: Evaluating the Newcastle NLE

An opportunity arose after the LAF instrument had been used to evaluate EEMeC to reuse it to evaluate a VLE supporting undergraduate medical education at the University of Newcastle-upon-Tyne in England. Their system was called the ‘Networked Learning Environment’ or NLE. By undertaking this second study the LAF instrument could be further tested and as a result issues of bias and validity could be further explored and triangulated. Although this was not strictly a part of the evaluation of EEMeC the use of the LAF instrument in Newcastle provided valuable empirical insights on the validity of its use for EEMeC and as a result it has been included in this thesis.

A short-form version of the LAF instrument was used for Newcastle’s NLE, the main difference between this and the one used for EEMeC being the collapsing of the effectiveness/utility/importance triad questions into the one stem. This is shown in appendix 7.3. The response option was limited to a single scale of: ‘strongly agree, agree, weakly agree, weakly disagree, disagree, strongly disagree’. This was a result of the instrument being run using Newcastle’s optical mark reader (OMR) system, for which this is the required format. Delivery therefore was using paper-based questionnaires for phases 1 and 2, optically mark-read and data provided on spreadsheet. Scheduling was for a single event on the 12 December 2003, for years 1 and 2 of the programme. The sample was made of those members of the cohort who were present at the end of term event and who completed questionnaires. The sample represents the students in the first two years of the Newcastle undergraduate medicine course. In year 1 87.8% of the population submitted responses,. In year 2 83.1% of the population submitted responses. The ability to support a community of practice has not been measured across the whole course. The instrument was uniformly presented to the study group and data uniformly returned and represented. The responses were all based on a 6-point Likert scale, which were coded as shown in table 7.10. Means were taken for each question for each cohort and slotted in to the Learning Design grid shown in table 7.11.

Question Responses	*Coded Ordinal Value*
Strongly agree	6
Agree	5
Weakly agree	4
Weakly disagree	3
Disagree	2
Strongly disagree	1

*Table 7.10: response coding used for the Newcastle NLE LAF evaluation. To convert to percentage scores, mean ordinal scores (x) were converted using the equation [(x-1)*20]*

	Mutuality	Competence	Continuity	Orientation	Reflection	Exploration	Convergence	Coordination	Jurisdiction
1	general								
2	general								
3	general								
4	x	x	x					x	
5	x	x	x			x			
6		x	x	x			x	x	
7	x				x			x	
8		x		x				x	x
9		x	x				x	x	x
10	x	x	x						
11			x	x			x		
12			x	x	x				
13			x	x	x				
14			x	x				x	
15		x		x		x			
16		x		x	x	x			
17			x	x			x	x	x
18	x	x					x	x	
19	x		x					x	
20		x	x						x
21	general								
22	general								
23	general								
Reliability alpha	.6795	.7285	.7899	.7012	.5105	.4946	.5836	.6985	.4926

Table 7.13: Learning Design grid for Newcastle LAF questionnaire. The reliability coefficients indicate that the reliability of the LDF mapping for data from the NLE can be taken as medium/high and therefore acceptably valid and internally consistent.

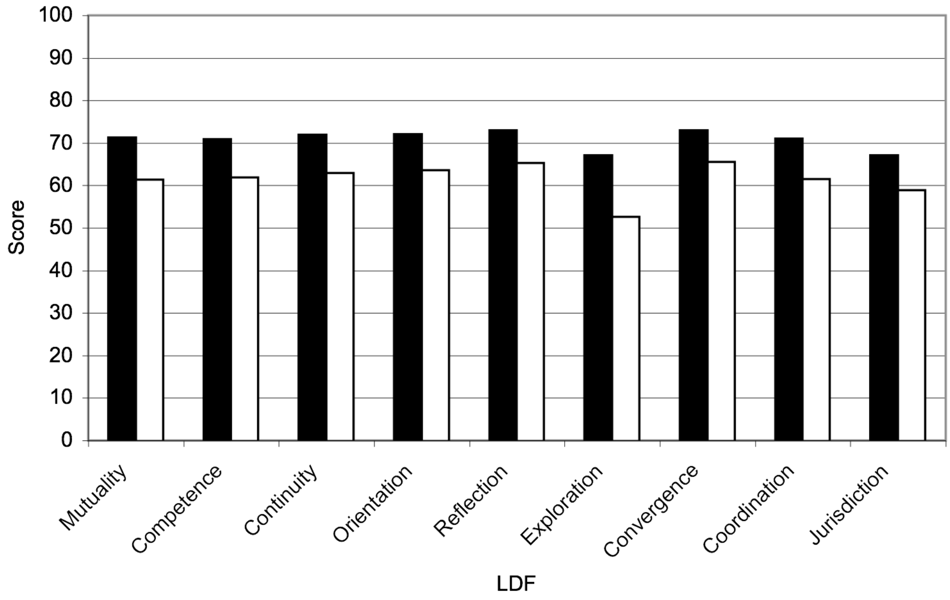

Figure 7.4: LAF factors for the Newcastle NLE for phase 1 medical students (in black) and phase 2 medical students (in white)

7.3.11.1: LDF Factor Analysis

Having established suitable internal validity and reliability, means of the percentage conversions were then taken for each factor. Aggregated for each cohort this is shown in figure 7.4.

7.3.11.2: LDF Factor Analysis Comparison – EEMeC and the NLE

For the purposes of comparison, the ranking of the LAF factors for EEMeC and the Newcastle NLE are shown in table 7.14.

	Edinburgh EEMeC LAF Ranking	Newcastle NLE LAF Ranking
High scoring factors	Convergence	Convergence
	Continuity	Reflection
	Competence	Orientation
Medium scoring factors	Orientation	Continuity
	Mutuality	Competence
	Reflection	Mutuality
Low scoring factors	Coordination	Coordination
	Jurisdiction	Jurisdiction
	Exploration	Exploration

Table 7.14: LAF ranking comparison for Edinburgh's EEMeC and Newcastle's NLE

The highest scoring factor for both systems is ‘convergence’ and the lowest scoring three factors for both systems are ‘coordination’, ‘jurisdiction’ and ‘exploration’. For these four factors the LAF ranking is identical for EEMeC and the NLE. The other five factors have been ranked differently: continuity is ranked 2^{nd} for EEMeC and 4^{th} for the NLE; competence is ranked 3^{rd} for EEMeC and 5^{th} for the NLE; orientation is ranked 4^{th} for EEMeC and 3^{rd} for the NLE; mutuality is ranked 5^{th} for EEMeC and 6^{th} for the NLE; and reflection is ranked 6^{th} for EEMeC and 2^{nd} for the NLE.

The ‘reflection’ factor is therefore the major difference between the two as the other rankings are within a place or two of each other. Whether these differences represent differences in the two VLE systems, differences in their respective course contexts or some other factor is not immediately apparent and would require further use of the instrument in both its long and short forms to be able to begin to answer this question. Certainly the investigation of the extent the LAF profile is common to medical VLEs, and to VLEs in general, would be both interesting and has the potential to be very illuminating. For EEMeC staff and students rated ‘exploration’ very differently. It would also be interesting to compare staff and student evaluations across different institutions to see whether these discrepancies persist or can provide identifying characteristics of the systems.

The testing of the LAF instrument against a different (although similar) VLE has clearly been able to provide a degree of validation and triangulation of its use on EEMeC. Although much could still be done to refine and extend this instrument and extend the use of theories of communities of practice as a basis for evaluating VLEs, the data and interpretations presented here have provided valuable perspectives on the ways EEMeC is perceived and valued by its user community. The further development of the instrument and the use of Wenger’s theories and models lies outwith this thesis however and will be pursued independently.

7.4: Discussion

The application of Morgan’s ‘culture’ metaphor as a stimulus for VLE evaluation has led to a discursive review of the proximal and distal cultural elements that make up EEMeC’s context of use, and an extensive review of EEMeC’s support of the MBChB configured as a community of practice. These approaches have proved to be useful in capturing many of the dynamics of a VLE-in-use and thereby contributing to a holistic evaluation process.

The culture-based evaluation of EEMeC indicates that there are a number of aspects that can be improved, particularly in the areas of course coordination (e.g. timetables), jurisdiction (e.g. rules and authority) and exploration (e.g. secondary learning materials). Analysis of its effectiveness, utility and importance show that the community using EEMeC has a reasonably realistic outlook, neither over- or under-rating EEMeC relative to their actual use and experience with it. A culture-based approach to evaluating VLEs does not provide information on what the VLE can do, nor what its features are or even how it is used. What it does help to provide is a perspective of how successful it is in serving its community of practice, and the ways in which it could be improved to benefit that community.

The LAF is not intended to be used as a prescriptive framework around which a VLE should be designed and built, as such prescriptive frameworks have been identified as inimical to professional practice (Lisewski and Joyce, 2003). It is descriptive rather than prescriptive; the themes used and the insights gained are recommended as tools to inform the reflective practices of those responsible for the design and delivery of VLE systems within coherent community of practice contexts.

Validation of the Learning Architecture Framework instrument indicated the limitations of the mapping between the instrument and the LAF. Further work therefore also needs to be done in refining this tool both in terms of the mapping between questionnaire items and the LAF and in carrying out longitudinal and parallel studies using this instrument. It is hoped that the LAF framework will provide a common language and framework with which to compare different systems or ways of working with VLEs. Further work is needed to establish whether this is viable. It should be noted that there are problems associated with this kind of approach when others seek to use it (Oliver, 2001); the utility of this work elsewhere may depend on the degree of alignment in approach and philosophy with that of the authors, and the contexts they are working in (Oliver, 2000). The use of the LAF framework is predicated on a pre-existing course community of practice, which for integrated subjects, such as medicine (Cook, 2001), has immediate relevance and utility. For other situations, for instance in modular programmes of study, where communities of practice may be weak (or even non-existent) then there may be less relevance in such a study.

Returning to the ‘culture’ metaphor, Morgan warns against the assumption that an external observer can really understand a culture; much is hidden and dependent on values and history that are not apparent to the observer. Furthermore truly impartial observation is always difficult as all individuals are situated within and informed by their own cultural contexts. The essence of culture is not therefore immediately available as it infuses both the practices and ways of thinking of its participants. Theory-driven approaches are therefore indicated over the more pragmatic and grounded approaches taken in earlier chapters. Coyne has framed theory-driven approaches as one of four philosophies that can be taken with respect of research and praxis (Coyne, 1995). The others are pragmatism, critical approaches and radical approaches. The analyses for the metaphors of ‘machine’, ‘organism’ and ‘brain’ were inherently pragmatic and that for ‘culture’ has of necessity been theory-driven (Coyne calls this ‘conservative’). The three remaining metaphor analyses will be approached from a more critical perspective.

Chapter 8: VLEs as Psychic Prisons

8.1: Psychic Prisons?

For Morgan the ‘psychic prison’ metaphor explores:

> *“the ways in which organizations and their members become trapped by constructions of reality that, at best, give an imperfect grasp on the world” (Morgan, 1997, p216)*

Morgan identifies factors relevant to this perspective as including the beliefs, value systems and orthodoxies of practice in an organisation. In particular this perspective challenges the rationality of systems by drawing attention to the effect of irrational and unintended influences on them. It also draws attention to the ethical dimensions of a system.

While the previous chapter used cybernetic concepts of control as a theme for evaluating VLEs, in this chapter it is the ways that a VLE can create ‘reality traps’ for its users that will form the basis of analysis. This chapter describes how the perhaps confusing metaphor of ‘VLEs are psychic prisons’ is operationalised by considering four different groups of ‘affordances’ of EEMeC, each expressed in negative terms, e.g. what EEMeC does not do or what its unintended consequences or effects are rather than what it does do (as for instance considered in chapter six) or what its intended effects are (considered in chapter five).

8.1.1: Constraint and Affordance

A number of biases and imprisoning factors have been associated with the use of computers in education (Landauer, 1995; Johnson, 1997; Healy, 1998; Littlejohn and Light, 1999), for instance:

> *“computers have a penchant for taking over whatever process they’re a part of, so that even when used as a means to some other end, they somehow become an end in themselves, monopolizing people’s attention and subverting other agenda” (Bromley, 1997, p117)*

While some of the effects of using a particular technology will tend to constrain practice, others will tend to be enabling, with most instances constituting a mixture of the two. For example, a move to a single VLE platform in an institution might constrain practice by its inability to support diverse practices while simultaneously enabling a common point of reference and framework for developing technology-supported learning across that institution. The mix of enabling and constraining effects of a technology on its users and environment may take several forms; direct effects associated with its use, indirect effects associated with its presence and influence, and effects related to the interdependence and interaction of the technology with other technologies, systems or contexts. As a means of spanning this continuum, the concept of 'affordances' of an environment can be used to address factors that encompass both enabling and constraining factors. According to Gibson, an environment's affordances are:

> *"what it offers the animal, what it provides or furnishes, either for good or ill" (Gibson, 1979, p127)*

The affordances of an environment are relative to the individual. In this respect there is a link between the affordances and ergonomics of a learning environment (Goodyear, 1997). The main (and indeed essential) difference between the concepts of ergonomics and affordance is that while the former is about design and intent, the latter is about perception and actuality.

A technology is generally conceived as being designed and deployed to address a need, to serve a function or to extend the abilities of individuals to interact with the world. This is an essentially rationalist perspective, which tends to ignore aspects of a technology's mutual dependency on and interaction with social systems. In the same way as Gibson ascribes affordances to environments, technologies will also have a range of perceived affordances which include the tasks and functions they appear to perform directly or facilitate in the environment into which they are introduced (Norman, 1988, p9). A technology may therefore be seen, by association, to constitute a micro-environment; one that enables particular ways of interacting with the world, often with both intended and unintended consequences (Conole and Dyke, 2004). In recent years the term 'affordance' has been used in a variety of different ways, particularly regarding the design of information technologies. A distinction has been made for instance between the information a system provides about itself and the actual functions it enables (McGrenere and Ho, 2000). However, it is the core ecological aspects of the concept which are useful to consider as a framework for evaluation (Boyle and Cook, 2004), and rather than consider what the system does afford, a 'prison' metaphor can be used to reverse this to consider affordances in terms of limitations and constraints. The evaluations under this metaphor will therefore consider the ways in which EEMeC distracts, disables and confounds its users, both individually and collectively.

8.2: Direct Affordances

The direct affordances of a VLE are what it enables or prevents for its users. Factors associated with direct affordance are utility and usability (McGrenere and Ho, 2000) and accessibility (Conole and Dyke, 2004). In terms of utility, aspects of this direct affordance have already been explored in previous chapters, for instance the 'fit to context' evaluation in chapter 5 and the use case scenarios presented in chapter 6. In this analysis however it is the ways that use is constrained by the system that are of interest and the unintended consequences of design. To that end it is the twin themes of usability and accessibility that will be the foci for analysis and evaluation.

8.2.1: Usability

Usability has been defined as follows:

> *"usability really just means making sure that something works well: that a person of average (or even below average) ability and experience can use the thing – whether it's a website, a fighter jet, or a revolving door – for its intended purpose without getting hopelessly frustrated" (Krug, 2000, p5)*

There are a number of approaches to evaluating usability, including direct or recorded observation, surveying user opinions, conducting compliance experiments, holding focus groups, conducting expert reviews and analysing log activity (Preece, Sharp et al., 1994; Axup, n/a). Some of these techniques have already been employed in this thesis although not for assessing usability. This replication of techniques points out a key aspect of usability evaluation, its focus on specific localised issues and problems. The usability of a system is a cumulative factor comprising of all the ways in which users' experiences are enhanced or thwarted by the system.

The sheer size of a VLE and the plurality of functions and ways in which it can be presented to its different users makes a complete detailed usability evaluation of a system like EEMeC a daunting undertaking and one that is certainly beyond the scope of this thesis. In the absence of a comprehensive usability analysis an alternative is to conduct a general and high-level usability review. In this case, rather than develop new instrumentation, existing work on web usability can be employed. Nielsen has developed 'heuristic evaluation' (Nielsen, 1999) which can act as the basis of such an evaluation. An evaluation instrument that used Nielsen's heuristic factors, the exemplar descriptors and his scoring system was developed as a *pro forma* for evaluators to complete. The completed instrument is shown in appendix 8.1.

Both Nielsen and Krug recommend using five evaluators to maximise the benefit of the evaluation for the minimum of effort. For the purposes of evaluating EEMeC, evaluators required some familiarity with the system but shouldn't be members of the MBChB community. They also needed to have some experience of designing web systems, as they needed to be able to identify and articulate problems they found. They also needed to be able to make meaningful assessments of the degree of the problem and assign a score to it. For this illustrative evaluation, two evaluators were selected from the same unit as the EEMeC development team. They had occasionally used EEMeC to publish their courseware to students but had little other experience beyond this. The results of their evaluations are shown in table 8.1 along with their notes and scores on how well EEMeC meets them.

Factor	Evaluators' Notes	Scores
Match between system and the real world	"as I am not a student or lecturer I wasn't familiar with some of the phrases/words" "I assumed DOS meant disk O.S. – a glossary might be handy. On the other hand I am not a medic :("	1:1
User control and freedom	"no access to portfolio as I don't appear to have a password" "leaving an archived session isn't easy to achieve"	1:2
Consistency and standards	"some things are confusing. What is the difference between 'EEMeC' and 'My EEMeC' when I am already logged on?" "not sure of the difference between 'EEMeC' and 'My EEMeC', each time I went 'home' it seemed to provide a different layout"	2:1
Error prevention	"perhaps some search hints if it draws a blank" "I accidentally visited and archived version of EEMeC and it was a good couple of minutes before I was aware of this"	0:2
Recognition rather than recall	"nothing came up I am aware of" "every page works on its own to my eyes"	0:0
Flexibility and efficiency of use	"found the 'search' slow and results confusing. The difference between 'annotate' and 'my annotations' is confusing" "the edit node icon is discrete yet memorable. Annotations, whilst similar, appear to operate very differently. It would be better maybe to use a yellow @ for example next to blue 'e'"	1:1
Aesthetic and minimalist design	"in general is ok but could be improved. Links at top left i.e. help are on top of each other, perhaps too close for example" "top navigation banner holds some functions not that handy, e.g. 'help' links to an email address, why not just have an email link instead? The top bar is also quite texty – maybe introduce some icons?"	1:2
Recognising and recovering from errors	"only stumbling block in my session was the portfolio as I did not have a password" "when I discovered I was in an archive session, it took me quite a while to get back to present day"	1:2
Help and documentation	"I didn't have any problem, the portfolio told me I needed a password and there is a way to get one" "the actual 'help' button (top right) is more of a contact button. It would be nice to have other tools like dictionary look-up or a glossary"	0:2

Table 8.1: Nielsen's usability evaluation heuristics (Nielsen, 1994) presented as an evaluation framework and used to structure a general usability review of EEMeC. Responses are generated from usability reports from two evaluators, both multimedia developers with limited previous experience of using EEMeC. Comments are aggregated for both evaluators. Scores are given as follows: 0 = None, 1 = Cosmetic, 2 = Minor, 3 = Major, 4 = Catastrophe. A copy of the blank form as provided to evaluators is in appendix 8.1

Although Nielsen's scoring system is ordinal rather than cardinal in nature, he recommends using the mean of ratings as a general measure of a system's usability. The mean of the evaluators' scores is 1.1; in this respect EEMeC has been rated as having no more than cosmetic usability problems. One point that is clear from this evaluation is the difficulty users can have in finding resources and information within such a large system. A number of students also identified usability problems related to difficulties of finding information in the free-text responses to the learning architecture framework. For instance:

> *"[the] search engine is not helpful as it does not find relevant pages. It can also be difficult to locate teaching packages and lecture notes" year 1 student, LAF questionnaire comments, appendix 7.4*

This has also been echoed by staff interviews (discussed in more detail in chapter 10):

> *"I don't find the search facility useful at all I must say … it only searches the HTML and so much of our information isn't in this but is based on keywords or higher order of classification. The word might be 'pulmonary' but I might put in 'respiratory' – it's not intelligent enough at the moment" staff interviewee 3, appendix 10.3*

There is therefore a degree of congruence between the evaluators' observations and the feedback from other EEMeC users.

This kind of usability evaluation is intrinsically 'action research' oriented as it is about making operational improvements to a system. In this respect it is another kind of software metric (as discussed in chapter 4) with all the limitations such methods have. This kind of evaluation is relatively function agnostic and it is therefore not a specifically VLE-focused usability instrument. However, as the evaluators identified meaningful problems, it has proved to be a good starting point for VLE usability evaluation. Recently there has been some consideration of usability in the context of online learning environments but only as much as sensitivity to the context of use is added to the kinds of criteria already discussed (Kukulska-Hulme and Shield, 2004).

Before moving on it should be noted that usability is not a one-way process towards a (perhaps unreachable) state of perfection where the system is perfectly usable, intuitive and responsive to the user. Indeed:

> *"at a minimum, usability represents social organizational values needed to make systems work in a functional sense. At times, usability can also support human values of moral import. But at times we need to give ground on usability to promote human values, and, conversely, at times we need to give ground on human values to promote usability" (Friedman and Nissenbaum, 1997, p6)*

Examples of these kinds of constraining affordances in EEMeC would include:

- The presentation of user-specific links rather than generic links on the 'My EEMeC' page allows the user to move easily within their immediate and current MBChB context but less easily beyond it.
- Partial anonymisation of discussion posts from a student perspective is a compromise between the persistence of an author's ID being attached to each message and student calls for anonymity when posting potentially compromising or contentious messages.
- EEMeC could be configured to track and record every interaction a user has with the system. However, in practice tracking is limited to the occasions when a user inserts or changes data

in the database. This is a compromise between overloading the system by trying to record excessive amounts of data and complying with both the University's Computing Regulations and the Data Protection Act (mentioned earlier in chapter six).

- The position of the EEMeC developer team as controllers of the system mitigates against users having full control to alter and otherwise affect the system directly themselves. As well as helping to preserve the consistency, quality and reliability of the system this may also have the effect of creating bottlenecks as requests may have to be queued at busy times.

8.2.2: Accessibility

Accessibility has already been mentioned several times in this thesis, as has the relatively low requirement for VLE's supporting medical education to accommodate disabled users. Despite this European/UK legislation regarding accessibility, particularly for publicly funded organisations, places a significant degree of responsibility on VLE developers and the traditional non-engagement with student disability in medical education has recently been challenged (Roberts, 2002; Tynan, 2002). The evaluation of a VLE's accessibility, even one with no actual disabled users, is therefore a valid activity, as much as anything because a system that is accessible to disabled users should be better accessible to non-disabled users as well.

How then can EEMeC's ability to support disabled users be evaluated when there are no disabled members of its user community with whom an evaluation can be performed? One alternative to an observational methodology is to perform tests of technical compliance with established accessibility principles. This involves submitting pages to online scripts that perform these tests and provide reports on the points where compliance is less than perfect. The most widely used and respected is the 'Bobby' service provided by the Watchfire Corporation at http://bobby.watchfire.com/. The service consists of a server-based application that parses a web page identified by a URL and detects instances of where the page fails to meet the W3C's WAI Content Accessibility Guidelines (see http://www.w3.org/tr/wai-webcontent/).

Because the Bobby remote tool connects to the site directly it cannot do so as an authenticated EEMeC user. To get around this a selection of EEMeC pages were accessed and then saved as static web pages. The URLs for these pages were submitted to Bobby for checking. There are two kinds of checks that Bobby conducts: accessibility and user checks. The former are specific instances where the page is non-compliant with the ideal model while the latter are suggestions for checks that should be made. Each of these has three levels of priority. The results of these evaluations are shown in table 8.4. In addition to these full Bobby and W3C (http://validator.w3.org/) reports for the EEMeC homepage were generated. The report from Bobby is in Appendix 8.2 and the one from W3C in Appendix 8.3.

The reports show very few priority 1 errors and few priority 2 or 3 errors. There are errors however indicating that these EEMeC pages are not completely accessible as defined by the W3C. Despite this, this evaluation doesn't mean that these EEMeC pages are not accessible although they can certainly be improved by observing the suggestions it makes. Accessibility evaluated in this way uses equivalent techniques to those employed by software metrics as discussed in chapter 4 with similar limitations. The optimum test would have been by evaluating actual EEMeC users with a range of disabilities – however as this is not available due to lack of qualified testers the Bobby approach will have to stand.

Page	Lines of HTML	Characters (no spaces)	P1 errors	P1 checks	P2 errors	P2 checks	P3 errors	P3 checks
Myeemec.asp	192	35867	2	10	2	16	2	13
Discussion: thread.asp	601	12937	0	9	3	14	3	10
Node.asp: year 3 home	69	8933	0	8	2	13	1	12
Node.asp: std text page	69	12405	0	8	1	13	1	10
Timetable	155	12328	1	9	4	14	3	10

Table 8.4: summary of Bobby accessibility validation reports for different EEMeC pages. The errors are the most important parts of the evaluation. P1= priority 1 and so on. A full Bobby validation report for the EEMeC home page is shown in appendix 8.2.

8.3: Indirect Affordances

Indirect affordances of a VLE are those changes and influences that it has on its environment. These effects are reactive and influence-based rather than proactive and activity-based, and may be reified in attitudes, inferences or interpretations, often going unremarked even by those affected. This section will review a number of such factors and the ways in which these factors are manifested in the MBChB as a result of the use of EEMeC.

8.3.1: Hidden Curricula

The concept of a 'hidden curriculum' is a reflection of the way that students interpret and redefine their curricula in light of the messages and processes they engage with in an educational environment and it is that part of their view of what they should be doing that is unintended by their tutors. Most usually this arises from reaction to attitudinal and emotional messages and signals sent out to students by their tutors and the learning environment as a whole (Snyder, 1971).

> *"it is easy to view the hidden curriculum as an accidental design, one on which the academic process has somehow managed to thwart the real interests of the university … this view of the situation, however, ignores the fact that the academy has itself created the system and that it serves a protective function, permitting a minimum amount of risk-taking and protecting the maintenance of the educational status-quo" (ibid p18)*

Snyder identifies many ways in which hidden curricula may be reified: in student roles and attitudes, approaches to change, the ways in which students interact with tutors and each other, their general learning and behavioural strategies, what is taken seriously and literally and what is not, and how authority is defined and in whom it is invested.

The idea that learning technologies create associated hidden curricula issues is not a new one. Roszak, a self-declared neo-luddite, has observed that:

> *"most educators … [treat] the computer as primarily a means of instruction. What they may overlook is the way in which the computer brings with it a hidden curriculum that impinges on the ideals they would teach. For this is indeed a powerful teaching tool, a smart machine that brings with it certain deep assumptions about the nature of mentality. Embodied in the machine there is an idea of what the mind is, and how it works. The idea is there because scientists who purport to understand cognition and intelligence have put it there. No other teaching tool has ever brought intellectual luggage of so consequential a kind with it" (Roszak, 1994, p241)*

In medical education students are actively encouraged to look to their clinical teachers as role models and to adopt their ways of working. Because many clinical tutors are seen to have very little engagement with EEMeC this has sent strong hidden curricular messages to students regarding the importance of the system. This is reflected in students' criticisms of their tutors for not using EEMeC (see appendix 7.4), it is likely that the absence of these tutors from EEMeC is sending out unintended and confusing messages to the students. Other examples identified in the free text responses include the way personal timetables stop after year 2 and delays and mistakes in the information provided to students sending message that they are disregarded and thought little of as students. There is a clear need therefore for the hidden curricula aspects of VLE to be identified and addressed:

> *"we must look very carefully at the disparity between the disparity and confusion created by the signals that students and faculty pick up from both the formal curriculum and the university's hidden curriculum; and we must examine the ways in which students respond or adapt to the formal and informal demands that the university makes on them" (Snyder, 1971, p144)*

The very essence of an online system also has implications for the student community. The existence of a 'digital divide' for students, between those that are better able to use e-learning opportunities and those that are not, has been identified as a potential problem:

> *"e-learning is very good for learners who are motivated and understand how to get the best from learning materials. They also need to know how to get the best out of the Internet. The*

ideal e-learner is digitally literate, probably self-sufficient, intuitive and self-motivated. The ideal e-learner is probably the ideal book learner. Where does that leave those who are reluctant learners, who need others to help their motivation, for whom the computer represents an artificial way of communicating, and those who seek help and reassurance while learning?" (Hills, 2003, p6)

At the time of writing there has been no comprehensive review of the hidden curriculum characteristics of EEMeC although increasing attention is being paid to these kinds of issues across the MBChB programme as a whole.

8.3.2: Orthodoxy and Heterodoxy: Sceptics and Dissenters

VLEs might be seen as a homogenising influence in that everyone uses the same system and therefore it might be expected that everyone uses that system in the same way. In fact for EEMeC neither aspect is true. In EEMeC heterogeneity is also a strong trope in that the specificity of different user roles, rights and permissions means that at least to a degree everyone experiences a different system, and certainly most of the data and analyses provided so far in this thesis demonstrates how EEMeC is used in very different ways.

Despite this, a convincing argument that EEMeC is a homogenising force might still be made. By affording much more structure and accountability, in terms of what is done when, in terms of tracking and monitoring its users and in terms of the constraints that the system affords explicitly, the VLE will tend to act as an influence for normalisation and control. However:

"if people are persuaded to believe that the computer contains all that is of value they will not look beyond the computer" (Roszak, 1994, p192)

In an open and democratic environment, critical attitudes to and engagement with the VLE need to be encouraged, and opportunity given to users to air scepticism and dissent. In EEMeC this is often reified in discussion board threads about problems in the course. If there is a groundswell of concern shown or if the issues are particularly important such expressions of dissent have led to curriculum review and change. Examples include cheating in exams, the efficacy of in-course assessment and the ineffectiveness of certain teachers. In this way EEMeC is a force for both homogeneity and heterogeneity in the MBChB, albeit in different forms.

8.3.3: Content and Process

There are major paradigm differences between designs of VLEs, for instance whether content dominates process or vice versa. In content dominated systems the primary goal is to organise content and present it to users in certain ways and sequences. In process dominated systems the primary goal is to organise and present processes for users to engage with. Although it has a strong content component EEMeC is more of a process-oriented system. Whichever form the VLE takes, it will have influences on its users as to what is important and worth focusing on. The balance between the two paradigms is well illustrated by comparing the triad questions on EEMeC's provision of secondary learning materials and its engagement with the course from the previous chapter. Although reasonably well rated, the provision of content was an aspect of EEMeC that failed to meet the needs of the majority of the MBChB community while they rated engagement with programme very highly.

8.3.4: Equity and Access

There are changes in equity and access for all users of a VLE that result from changes in the underlying medium of their learning environment as a whole. This is reflected in the fundamental requirement for access to Internet-connected computers (whether provided personally or by the institution), the offset of printing costs by putting lecture handouts and study guides online and the change in the temporal and geographical constraints on user participation and engagement.

Before EEMeC (and the new Edinburgh MBChB) began, communications between staff and students took place in face-to-face encounters, email and paper-based post. Students themselves communicated with each other predominantly face-to-face and to an extent using email. All handouts and course materials were provided for free and most bulk communications (such as exam results) were done via public (physical) notice boards.

Since the introduction of EEMeC the majority of non face-to-face staff-student communication has moved to the EEMeC noticeboards, to some extent via email and only very occasionally by post. Students continue to interact face-to-face but they have also taken to using the EEMeC discussion boards very heavily and use email and to an extent instant messaging fairly ubiquitously. While pared down study guides are made available in print for free at the start of each academic year many other materials are now solely made available via EEMeC and student concerns over the resulting printing costs have been made by students in committees and liaison meetings for a number of years.

As an indication of changing attitudes to computer ownership, survey data from introductory computing skills sessions at the start of year 1 show both a steady increase in computer ownership (figure 8.1) and a steady reduction in both positive and negative attitudes towards computing (figure 8.2). This latter point is taken to indicate how students no longer see computers as particularly distinct in their learning environments but rather a merging into the background of affordances of the learning environment as a whole.

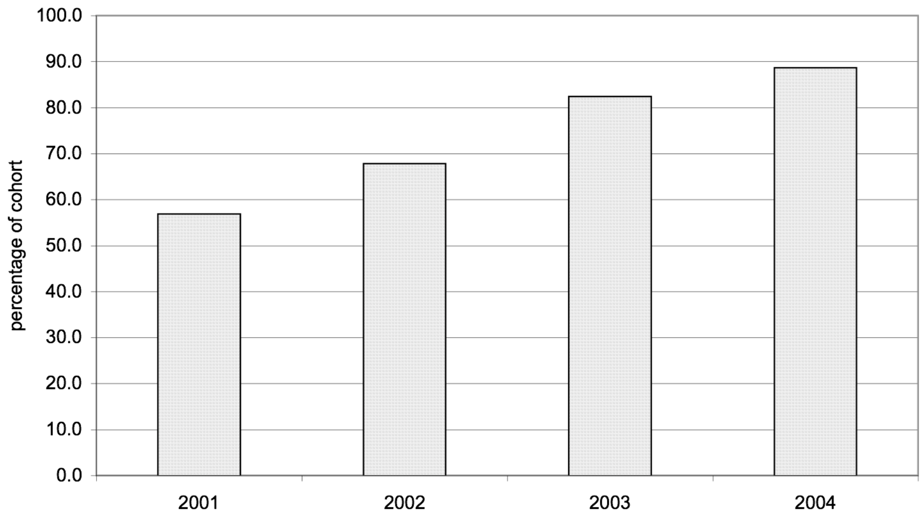

Figure 8.1: student ownership of computers at entry to year 1 of the Edinburgh MBChB programme.

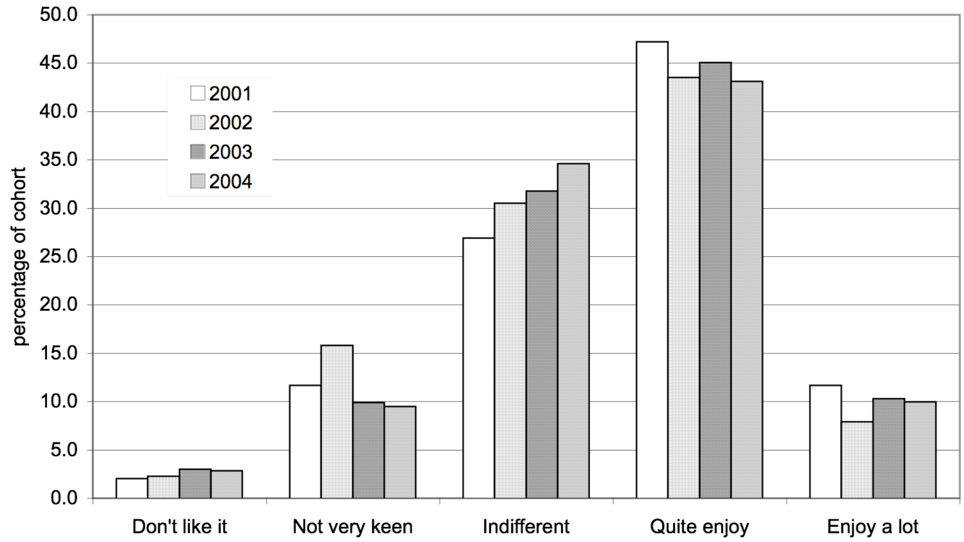

Figure 8.2: student attitude to computing at entry to year 1 of the Edinburgh MBChB programme.

Both the College and the University have invested in improving computer availability to students and the increasingly blended nature of the MBChB programme is now part of the recruitment process; the EEMeC demonstrations during open days are a big draw to the many potential students that attend. The growing amount of EEMeC traffic originating outside the University network (shown in chapter 4, figure 4.13) is an indication of the growing access from hospital and personal computers.

8.3.5: Shared Community Spaces

One of the main differences between networks and communities of practice is the grounded and locale-specific dimensions of the latter (see chapter seven for more details). A VLE may provide part of the shared activity space for some or all of its user community and as such may constrain and afford all sorts of activities and interactions. This was well outlined by the observations of a number of year 4 students when asked about the closure of a dedicated medical library in the University's central area and its merger with the main University library service. Their response was that where else other than EEMeC can they now go and find a concentrated and community-focused activity space? If the VLE becomes a refuge, possibly the only one in an increasingly pared-back university environment, then it will inevitably have a major controlling impact on that community.

8.4: Interaction Affordances

These are imprisoning effects resulting from the interdependence and interaction of a technology with other technologies, systems or contexts. For a VLE this may take many forms but recently these have tended to be conflated into the concept of interoperability (or the lack of it).

Interoperability is a mutual condition of two or more systems that subscribe to the same protocols, formats and methods of sharing and exchanging data and services. There are now common specifications for many forms of data used in education, many of which have emerged from the work of groups such as IMS Global (http://www.imsglobal.org).

There is often more than one specification available for a particular area or topic, and in others, even if the same base specification is used, it may be interpreted and implemented in quite different ways. Interoperability is therefore less rational than it may seem, and whether or not it is implemented, it can impose constraints and affordances on systems such as VLEs. Interoperability is not just something that is turned on or off; there are some fundamental questions that it raises.

- Firstly, why interoperate at all and if so with what or whom? Examples may include local student records, human resources, library and finance systems as well as banks of external resources or service providers. For EEMeC this should have included the student records held by Registry but as Registry have not been prepared to allow direct access to the data this has not been possible. The result is that EEMeC's student record has very often been out of sync with the institutional student record. Not only has this situation create confusion and any number of problems but it also runs counter to the principles of UK data protection legislation.
- Secondly, which interoperability specifications and profiles should be used? The interoperating systems must be using the same specifications. As there may be many

interpretations and alternatives this may constrain either the choice of partners and the information and resources that can be shared, or more fundamentally it may constrain which system can be used at all. EEMeC has been involved in two JISC funded interoperability research projects, DEVIL[1] and D+[2], which have successively (and successfully) built interoperability channels between EEMeC and a number of library systems. A major part of this has been interpreting resource metadata between the MARC record format held by the libraries and the IEEE LOM format used for describing learning resources used in the VLEs (Alexander, Broadhurst et al., 2003).

- Thirdly, how can interoperability be established? Means must be put in place to securely and efficiently pass information in and out of the system. The implementation of what can be fairly complicated technical and semantic structures can take significant resource and investment to achieve involving as it does the use of technologies like extensible markup language (XML) and enabling often very different systems to be able to talk to each other. As EEMeC is just one of a number of specialist VLE systems some of the component subsystems have been moved outside the VLEs so that their services and resources are available to all. One such sub-system is 'ResManager', a resource management tool that stores metadata on all of the collected systems' learning resources. It streams data into the VLEs using either the IEEE Learning Object Metadata model (LOM) or Reduced Site Summary (RSS) formatted XML.
- Fourth and last is what happens when the interoperability is established and data and resources are being shared between different systems. Services and functionality may become dependent on this shared information and the failure or absence of one system may have serious knock on effects on the others. Partial service failures have been experienced by EEMeC users when interconnected external systems, such as the learning activity sequencing engine EROS or the ATHENS devolved authentication service, are disabled or malfunctioning. This is described using concepts of close or loose coupling. Closely coupled systems are particularly dependent on each other and therefore vulnerable to failure in any part of the system. These concepts are well described in the literature on systems failure (Sauer, 1993; Tenner, 1996; Collins and Bicknell, 1997).

As was mentioned in chapter 5, the recently published 'E-Learning Framework' (http://www.elframework.org/) could be adapted to create an evaluation instrument that looks at interoperability for a VLE.

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1 'Dynamically Enhancing VLEs with Information from the Library' was a joint project between the University of Edinburgh and the Open University in 2002-2003 that looked at both technical and organisational solutions to exchanging information between library and educational systems.

2 D+ was a successor project to DEVIL and ran from Spring to Autumn 2004.

8.5: Affordances of Agency

A key aspect of any environment is how much freedom and control individuals and groups within it have. This can be encompassed in the concept of 'agency'. The amount of agency in a VLE is therefore an important indicator of how it enables or constrains its users. Aspects of agency have already been covered in the discussions regarding affordance in this chapter. However there are many aspects of agency that are more direct than those covered so far. These can be organised into three levels; organisational, group and individual.

8.5.1: Organisational Agency

This concerns the agency that an organisation has with or within a system. For EEMeC the relevant organisation is the MBChB rather than the University and in this respect the organisation has great agency with and within its VLE, as EEMeC belongs solely to the MBChB. Scarborough and Corbett have observed that:

> *"autonomy and control is achieved by organizing within the technology process and not outside it" (Scarborough and Corbett, 1992, p22)*

This would seem to be a clear recommendation of a 'DIY' VLE rather than an 'off-the-shelf' solution; this has been the approach taken with EEMeC. Some of the advantages and disadvantages of these two approaches have already been discussed in chapter 2 but for the purposes of this chapter the issues will be reprised in the context of autonomy and agency.

The EEMeC approach has not been one of absolute devolution however as the use of other systems in the MBChB has been discouraged in order to ensure that there is no confusion or conflict between such systems. This has been achieved by endeavouring to offer at least the same if not better service and functionality than any standalone system could offer. Certainly it would seem that where other medical schools in the UK have multiple systems covering different aspects of their courses (Cardiff, Birmingham and Manchester are examples) they have lost the common focus that a single integrated platform can bring (Cook, 2005).

The same argument has been made against EEMeC. In Edinburgh the centrally supported VLE is WebCT, which is used for many of the modular, optional and granular degree programmes in other areas of the University. There has been pressure put on the MBChB over time to adopt WebCT, both directly, through requests and drafted policies, and indirectly, by tying support and integration with other University services solely to WebCT. This has been successfully resisted; both on the basis that WebCT can only offer a fraction of what EEMeC offers, and on a local imperative to retain control of the technology process close to the MBChB. In this way EEMeC is not an absolute DIY system but it is a compromise between an absolutely centralised and absolutely devolved VLE.

The agency afforded by EEMeC is therefore very high at the MBChB organisational and community levels level but potentially less so for individuals. Agency is tempered by the dependencies and relationships that EEMeC and the MBChB have with the University and other organisations. EEMeC must comply with legal and institutional regulatory constraints and is dependent on centrally provided services such as network infrastructure and student computing labs.

8.5.2: Group Agency

Group agency is the balance of control and constraint afforded to different groups within a system. EEMeC differentiates between users as belonging to the following general groups:

- Students have limited agency; EEMeC is non-negotiable and students are expected to use it at least for complying with submitting coursework, reading notices, checking timetables and booking projects and teaching slots. Some pages and many tools are staff access only. However, their opinions and feedback are constantly sought to help improve EEMeC and there are student reps on the EEMeC user group. Student feedback on EEMeC is also obtained via the individual course evaluations and the year planning and staff-student liaison meetings.
- Staff users are split into three subcategories:
    - General staff users have access to EEMeC but cannot access any of the extra tools. Staff users can influence EEMeC development by making requests directly to EEMeC or via various committees.
    - Special staff users are those that have been given access to extra tools and resources such as the ability to post notices, edit pages, access student portfolios or assessments or upload timetables. This group usually comprises of those who have a more direct and substantive role in the MBChB and therefore have more of a say in how EEMeC is used and developed.
    - Guest users have very reduced access and have no say in how EEMeC is used or developed.
- Developers have complete access to and control over the system. The EEMeC manager makes all operational decisions and sets operational policy as informed by interactions with course managers and other key staff.
- MBChB managers have significant strategic agency but limited operational agency within EEMeC. This is not because they are operationally excluded but because they tend to accept the service as provided and target their energies to other issues within the MBChB.

8.5.3: Individual Agency

Individual agency is directly related to the system as experienced by the individual user. Agency for the individual EEMeC user is limited, as the appearance, functions and performance of the system are controlled from the server and are only minimally customisable at the client end.

Limited agency is afforded in that users can change their passwords, create and review annotations and change their personal profile details. The most used part of EEMeC, the discussion boards, have a high degree of agency in that users can start discussion threads, post messages directly without them being filtered by a moderator and, on occasion, report inappropriate messages for attention of senior staff. Other aspects of user agency include named staff having edit access to parts of the system, the way students can book projects and clinical sessions and the way they can build up their portfolio over time. Human agency in technology has been identified as a moral issue:

> *"system design should seek to protect the moral agency of humans and to discourage in humans a perception of moral agency in the computational system" (Friedman and Kahn, 2003a, p56)*

Friedman and Kahn's recommendations are to make sure users are not treated like machines themselves and to make sure the system does not impersonate or represent itself as having 'intentional states'. EEMeC has been designed and built with usability and efficiency for its users as a prime driver and as such users' tasks are designed with the maximum appropriate agency. Furthermore EEMeC is part of a blended learning environment that attempts to mix the best of face-to-face and electronic approaches to teaching and learning. EEMeC and its use context therefore respect the first requirement. Regarding the second requirement, EEMeC's developers have discussed making EEMeC more intentional as a way of making the interface more 'friendly' to users. Other than the 'My EEMeC' page this has not been implemented, although this was more to do with concerns that it would trivialise the system and distract users than out of ethical concerns.

EEMeC has purposively sought a clean interface design and 'look and feel' throughout its development. This was originally derived from the principal designer's wish to employ the HCI guidelines from Apple Computer (Apple Computer Inc, 1996) and the look and feel of Apple publications (Davis and Merritt, 1998). Over time the design has matured and specific sections have specific icons and other adaptations but the look and feel has been kept consistent, for instance the same icons are used for equivalent functions in separate subsystems. Very occasionally students request something more visually exciting but this has usually been turned down, as the shared wish of both the development and MBChB programme management teams is to retain EEMeC's clean and uncluttered design.

8.6: Discussion

The evaluation of the way EEMeC can act as a ‘psychic prison’ by constraining its users has covered concepts that have been grouped under the general ecological concept of ‘affordances’, where a VLE’s affordances equate to its enabling and constraining properties and the effects it has on its context of use. Despite a number of criticisms and problems associated with the use of this term (Norman, 1999; McGrenere and Ho, 2000), it has provided a useful theoretical lens to frame an analysis of constraints in a VLE. Some of the problems associated with its use (when used to describe design) have been avoided by considering affordance in a negative sense by looking at the ways the system constrains rather than enables its users, in particular some of the unintended consequences of its use.

Direct negative affordances were equated to the twin factors of system usability and accessibility. EEMeC was found to be less than perfect in respect of these two factors although the problems found were mostly cosmetic in nature. The main concern raised was the difficulty that users can have finding information in the system. This review of direct affordances was, by necessity, limited, as there are so many different tools, functions and ways of interacting with the system. This is a clear indication of how a VLE differs from a single tool or website which has a more limited range of direct affordances.

The review of EEMeC’s indirect affordances covered a range of factors, including the way the VLE can contradict the overt language and values of its context of use, and how it can effect equity of access and resources for its users. Regarding the former, EEMeC was discussed as having hidden curricula influences in a number of ways, including the way perceived staff absence from the system and problems with accuracy of information sends negative messages to the students about their importance and value in the programme. Concepts of equity were discussed in terms of the way printing costs have been transferred to students by placing lecture materials online rather than providing handouts, and more directly by the essential requirement for any EEMeC user to have access to a networked computer.

Interoperability was a third affordance factor, considered as both the opportunity and ability to interoperate. While EEMeC has the potential to interoperate with many systems, the opportunity to do so within the University of Edinburgh has been limited by the owners of appropriate interoperability targets being unwilling to make them available. The few interoperability channels that have been established have proved to be very useful. Where interoperability channels are opened there are risks of the VLE and therefore its users becoming dependent on systems outside their control.

A fourth factor considered the agency EEMeC affords different entities such as organisations, groups and individual users. EEMeC has significant agency at the organisational level, differing levels of agency for different groups and limited agency for individual users. This reflects its organisational status as an extension of a university degree programme.

Although there are many ways that a VLE could act as a psychic prison, EEMeC can largely be seen as constraining its users in ways that are indicated or required by the kind of system it is and the environment in which it was developed and is being used. The problems reported with users finding information and resources are indication that the system's complexity or size may be greater than is appropriate for most users. While both students and teachers report problems with finding material, EEMeC's developers do not share this experience as they have full access to the back end of the system. This is an indicator of the agency that EEMeC's developers have and a source of misunderstanding between them and the community they serve.

It is perhaps overstated but nonetheless true that:

> *"every humanly crafted thing will be flawed, warped, skewed" (Roszak, 1994, p193)*

EEMeC like any VLE can never be perfect, indeed perfection would be hard to quantify let alone achieve, as all its different participant users are likely to have different and potentially conflicting needs. VLEs should therefore not be considered as a panacea for educational problems as they inevitably introduce problems and inadequacies of their own. These problems may however be turned to educational advantage:

> *"the best approach to computer literacy might be to stress the limitations and abuses of the machine, showing students how little they need it to develop their autonomous powers of thought" (Roszak, 1994, p242)*

There are many ways in which a VLE can act as a psychic prison for its users. It is perhaps a factor of VLEs' relative novelty that analyses of such factors do not yet seem to have appeared in the literature. It is a concern however that these issues should be considered and factored in to VLE evaluation:

> *"unforeseen consequences stand in the way of all those who think they see clearly the direction in which a new technology will take us" (Postman, 1992, p15)*

The directions that EEMeC has taken over time are considered in the next chapter.

Chapter 9: VLEs as Flux and Transformation

9.1: Change 'is'

For Morgan the metaphor of change has two organizational forms; the organization considered within a larger context of flux and change, i.e. the subject of change, and the organization as the agent of change within an environment. Change is implicit in the log file analyses of chapter four, and it has been mentioned several times in the contextual analysis in chapter five. Several of the cybernetic evaluation criteria used in chapter six, such as '*the importance of redundancy*' reflect the ability and capacity of a system to innovate and develop over time and '*continuity*' is one of Wenger's Learning Architecture Framework components used in chapter seven. What then can be added by concentrating on flux and change as central themes of a VLE evaluation?

Although change and development were considered in earlier chapters they did not describe how EEMeC has developed over the years nor what effect it has had on its context of use over time. EEMeC, because its development team has been constantly trying to extend and improve the system over time and because its users are constantly adding and changing its information and resources, is not strictly the same system from day to day let alone year to year. In previous evaluations EEMeC has been discussed as if it has been a constant and homogenous entity over time but that is not the case. In this chapter this misconception will be addressed and the way that EEMeC has changed and caused change over time is used as a basis for evaluating it.

Methodologically the evaluation of change could be pursued in a number of different ways, ranging from creating and evaluating historical accounts, through analysing personal accounts and diaries to perhaps more archaeological approaches that look at the historical remains of previous VLE system states in the current system. This latter approach, considering what has been termed 'legacy code' within the software industry (and perhaps best exemplified by the concerns over Y2K code running up to the millennium), although not pursued in this thesis, is one that could perhaps be of particular interest to third-party evaluators working to understand how a contemporary VLE system was developed over time. The method adopted in this chapter was to evaluate historical accounts of the development of EEMeC using two ideographical frameworks, one derived by the author and colleagues and one derived from the work of Everett Rogers (Rogers, 1995).

9.1.1: Modelling Change

There have been a number of writers on technological change (Scarborough and Corbett, 1992; Wilson, 1992; McLoughlin, 1999; Davies, 2004) and in particular change in educational settings (Ford, Goodyear et al., 1996; Koper, 2000; Agre, 2002; Oliver and Harvey, 2002; Cornford and Pollock, 2003). Perrolle for instance identifies different kinds of change that can serve as a general working typology (Perrolle, 1987, pp32-34):

- Dynamic stability: "*slow changes during which the important processes and structures of society are preserved*".
- Structural change: *"when the number of positions in a social structure is changing or when the roles for various positions are being redefined"*. This has two key components; 'structural differentiation' when "*new specialised roles develop*" and 'social integration' that "*connects new elements and coordinates their functions*"
- Revolutionary change: "*rapid, disruptive and often violent state changes from one relatively stable form of society to another*"
- Catastrophic change: where "*the society, community, or company does not survive*"

Morgan employs four models of change in respect of organizational analysis and evaluation. Each of these represents a pluralistic and holistic view about how change can occur and what happens as a result:

- *Autopoiesis* (after Maturana and Varela) is a term for the tendency for living systems to be autonomous, circular and self-maintaining. This is essentially a holistic perspective, stressing the interdependences of the entity with its environment. It is also related to metaphors of 'organism'.
- *Chaos and complexity* is derived from chaos and complexity theory and is about the way systems tend to work around 'attractors' and the way they switch from one stable phase to another.
- *Mutual causality* is about how chance and serendipity can lead to new forms of organization and stability.
- *Dialectical analysis* is about the intrinsic contradictions in a setting and negotiating the resulting paradoxes. In particular it is about negotiating the many opposing continua in a system such as quality vs quantity, freedom vs authority, individual vs organisation, and complexity vs simplicity.

9.1.2: Diffusion of Innovations

Of particular note is Rogers' work on the 'diffusion of innovations' (Rogers, 1995), which provides a range of ways and means to approach the analysis of the adoption of a new technology (or potentially any other innovation). For Rogers:

> *"diffusion is a kind of social change, defined as the process by which alteration occurs in the structure and function of a social system. When new ideas are invented, diffused and are adopted or rejected, leading to certain consequences, social change occurs" (ibid, p6)*

Rogers defines five characteristics of innovations (ibid, p15-16): the 'relative advantage' of the innovation over its predecessor(s); the innovation's 'compatibility' with the context of use; the 'complexity' and other difficulties associated with implementing the innovation; how much 'trialability" and prior experimentation is possible prior to adoption; and the 'observability' of the results of the innovation to others. Rogers also stresses the role of communication in diffusion:

> *"one of the most distinctive problems in the diffusion of innovations is that the participants are usually quite heterophilous" (ibid, p19)*

In other words, if the participants have relatively little in common then the diffusion process will be slower and may indeed stall altogether. This is particularly the case when one party has vested interests in the innovation and the other has not. Rogers identifies three main types of decisions: 'optional' where the decision is up to individuals; 'collective' where decisions are consensual across a community; and 'authority' where the decision is made by a relatively small number of individuals in positions of power (ibid, p37).

Rogers also identifies a five-stage typology for the categories of adopters: innovators, early adopters, early majority, late majority and laggards, and he provides a typology of the impacts and consequences of adopting an innovation:

> *"consequences are classified as (1) desirable versus undesirable, (2) direct versus indirect, and (3) anticipated versus unanticipated" (ibid, p440)*

Many of these ideas are reflected in other approaches to modelling and describing change in educational settings (Jochems, van Merriënboer et al., 2003).

9.2: Evaluating Change in Educational Settings

It has been recommended that change within complex system is represented by more than one model (Davies, 2004). Models might use *directional* approaches that look at the sequence or chain of events or *network* approaches that look at the interactions between components in a changing system. Unless a change process has been strictly linear and causally sequenced a network process should be adopted.

Examples of directional approaches are to be found in tools for evaluating public programmes and include the Logical Framework (Knowledge and Research Programme on Disability and Healthcare Technology, 2004) which looks at four stages (activities, outputs, purpose and goals) and the Logic Model (W.K. Kellogg Foundation, 2001) which looks at five stages of change (resources and inputs, activities, outputs outcomes and impact). Examples of network models include soft-systems (Checkland, 1981) and the 'task-artifact cycle' (Carroll, Kellogg et al., 1991). However none of these is purposively designed to capture the dynamics of change in an educational setting. To that end an education-specific change evaluation framework was developed.

9.2.1: Analysis of Impact, Determinism and Adaptation

A tool was needed to capture the multidimensional and often unintended effects that interventions have in educational settings. These effects may take a number of forms: effects related to the presence of an intervention, effects related to the affordances of an intervention and effects related to the interdependence and interaction of the intervention with other interventions, systems or contexts. In the context of learning technologies, because programmes or applications are easy to see as distinct artifacts, this has often been the mindset of researchers in evaluating them. However:

> *"artifacts do not actually change an individual's capabilities. Rather, they change the nature of the task performed by the person. When the informational and processing structure of the artifact is combined with the task and informational processing structure of the human, the result is to expand and enhance cognitive capabilities of the total system of human, task, and artifact" (Norman, 1991, p22)*

The use of the term 'intervention' is therefore more appropriate than 'artifact' as the concept of intervention indicates a state change in the 'total system' as well as the entity whose presence is the stimulus for change. The contextual interdependencies of an intervention and its environment are dependent on the impact of one upon another across a range of different domains.

The derivation of the framework started from a list of factors that surround the application of strategic use of learning technologies: pedagogy, community identities and relations, processes, staff development, management of change, orientation of systems, integration with surrounding environments, policy and politics, technology, power and ownership and accountability. This drew upon both practical experience of managing learning technology services in higher education and literature sources (Perrolle, 1987; Ford, Goodyear et al., 1996; McLoughlin, 1999; Brown and Duguid, 2000; Agre, 2002; Oliver and Harvey, 2002; Cornford and Pollock, 2003). Scott for instance proposes four contexts for learning (Scott, 2001, pp37-40): knowledge contexts – prior knowledge and meanings, what is and is not taught; power contexts – the controls and shaping of strategy, policy, content, process; teaching and learning – degree of restriction or freedom, methods, interactions; and structural contexts – spatial and temporal arrangements

9.2.2: The AIDA Framework

The various change and impact factors identified so far were set up as a basic evaluation pro forma and piloted among a small number of academic staff. Feedback was used to reorganise and redesign the framework. This second version was rendered as a web-based tool and piloted again. This led to a second set of improvements. Although no new factors were identified at this stage, discussions as to the nature and extent of change, whether evolutionary or revolutionary, proved particularly useful. This third version of the framework was written up and published (Ellaway, Dewhurst et al., 2002; Ellaway, Dewhurst et al., 2003). A third set of improvements led to the following seven components:

1. *Freedom:* Human activity systems are often 'fuzzy' in that their rules, meanings and procedures are emergent, negotiated and personally and socially constructed. Fuzziness can be equated to freedom, in that freedom is a relative measure of the constraints imposed in an environment.
2. *Granularity*: An intervention can create changes in an environment's granularity and complexity, for instance in its roles (e.g. where specialism increases or decreases), or processes (e.g. where tasks have greater or fewer steps or more or less complex components). There may also be changes in the balance of heterogeneity and homogeneity in the environment. Complexity, like energy, is rarely destroyed. It simply changes from one form or location to another. A technology may reduce external complexity for its users but at a cost of increased internal complexity.
3. *Interaction:* An intervention may change both the form of, and opportunity for, interaction, both between individuals and between individuals and objects and information. While some interactions are remediated, retaining their essential form (such as writing essays or performing MCQs), other interactions are augmented, taking on quite new forms (such as in hypertext or 'impossible' virtual worlds). Concepts such as 'value', 'presence', 'validity' and 'accountability' are challenged and renegotiated in the context of technology-mediated environments.
4. *Pedagogy:* The use of technology can have a wide range of direct and indirect effects on teaching and learning. These might be at both learner-specific and strategic curricular levels. This is predictably the area that has seen the most research activity in the past, but often, learning technologies are modelled and evaluated solely within a pedagogical context, which can often hide or obscure the bigger picture. The AIDA framework places pedagogy as just one factor in a larger context. Changes in pedagogy may include how a subject is conceived, its epistemology, how it is represented, and how it is assessed.
5. *Resources:* An intervention can significantly affect resourcing patterns within its context of use. Spending time or money on one intervention will mean not spending it on something or someone else. Thus, not only are there costs to be met, but also compromises to be made against other demands within limited and often shrinking and over-burdened budgets for teaching and learning. Interventions may therefore have direct resource implications or displaced resource implications.

6. *Politics:* All human activity systems have political components. Interventions may change how and when decisions, strategies or policies are made, activities are undertaken, resources are committed or authority is imposed. Political effects may also be manifested in the interactions between different communities of practice, particularly in the form of boundary encounters where the languages, meanings and practices are brokered and negotiated between the communities.
7. *Distal Factors:* The previous six factors are proximal to the intervention's immediate environment. This seventh factor consists of the collected external (distal) effects from beyond the immediate sphere of influence. These could include the influence of regional, national and international strategies, commercial factors, social change, the intrinsic nature and partiality of software applications and their developers, or paradigm shifts in the form and evolution of the technical mainstream.

Applying the AIDA framework involves completing a pro forma that gets the evaluator to record the nature, scale and importance of change for both its positive and negative aspects. To evaluate EEMeC this chapter will first present a historical account of how EEMeC has developed and interacted with its context of use and then analyse that account using Roger's diffusion models and the AIDA framework.

9.3: A History of EEMeC

Historical research is:

> *"an act of reconstruction taken in a spirit of critical enquiry designed to achieve a faithful representation of a previous age" (Cohen, Manion et al., 2000, p158)*

Such an approach is dependent on the evidence that can be brought to bear on the problem and the quality of the evidence, both from issues of validity and accuracy. In order to analyse how EEMeC has itself changed and how it has influenced and created change in others it is necessary to record the events, issues and developments associated with it over the years. A number of historical accounts and documents have been included in the appendices as evidence in support of this and are listed and described in table 9.1.

Appendix 9.1: A History of EEMeC to July 2000	This document charts the influences and background to the decision to create EEMeC and the first year of its operation. It also includes contemporary reports from 2000 from the author on how EEMeC is expected to develop in the future.
Appendix 9.2: A History of EEMeC from 2000 to 2004	This is an account of 120 or so events and developments associated with EEMeC from July 2000 to the end of 2004.
Appendix 9.3: EEMeC Service Level Agreement	This is the agreement from February 2002 that sets out the responsibilities and patterns of information exchange between the main parties in the MBChB.

Appendix 9.4: A Nodal Learning Environment Architecture	This is the proposition paper written in May 2002 where the author sets out the plan for a nodal information system architecture for VLEs such as EEMeC.
Appendix 9.5: EEMeC Users Group, February 2003	These are the minutes of the EEMeC Users Group that met in February 2003.
Appendix 9.6: EEMeC Users Group, June 2004	These are the minutes of the EEMeC Users Group that met in June 2004.

Table 9.1: documentary evidence presented as an account of EEMeC's history and development. All material is to be found in the appendices at the back of this thesis.

In addition to documentary evidence, the server and VLE log files (see chapter 4) can also be used as evidence in support of historical evaluation. Because log files are records of computer events over time, they are relatively quantitative longitudinal records that can be correlated with document-based historical accounts. A plot of traffic to EEMeC over time was shown in chapter 4, figure 4.10.

Historical evaluation is about reviewing the quality of the data provided and is based on a critical review of the evidence from external and internal perspectives (Cohen, Manion et al., 2000, p162):

- External criticism: because the author of this thesis has had a major role in the development of EEMeC all the evidence used is primary in nature. There is no question whether the authors are who they say they are and the sources are those collected by the author at the time events took place.
- Internal criticism: the author's original accounts have been checked, amended and extended by three other individuals who have been involved in the development of EEMeC and have therefore been validated as accurate from an EEMeC development perspective. However the accounts given are those of individuals directly involved with the development and day-to-day running of EEMeC and as such could be partial or biased, both as regards what constitutes important data and how that data should be represented. The perspective taken is one of responsibility for and advocacy of the system and therefore omits the perspectives of those not in this position. The logfile data has however been machine generated and there has been no reason to doubt its veracity.

The quality of the data is therefore accurate and valid although, since it has been created from the perspective of the EEMeC development team (and in particular the author), some observer bias is possible. However, as EEMeC has not been of significant foreground interest to any other individual or group, the accounts and data presented are the best available and has been gathered and generated with care and attention to objectivity, representativeness and accuracy.

9.4: Analysis of Change Factors

The results of evaluating EEMeC against the AIDA framework are summarised in table 9.2. This involved a description of the positive and negative impacts for each of the seven factors followed by a rating of the impact on a scale of 0-5. An additional weighting factor was added as an indication of the relative importance of each factor relative to any other; this was on a scale of 1-3. The resulting scores are shown graphically in figure 9.1.

		Impact description	Impact size	Weighting
freedom	+ve	Students have more freedom where, when and how they study. The logfiles show engagement with the MBChB continuing over weekends in the evening and night and at locations external to the University. Many students have reported using EEMeC to stay in touch with the MBChB and their peers while travelling, in particular during the 8 week elective in year 5, which most students spend overseas. Students also report that EEMeC has been a constant support across academic years in which values and practices can change quite dramatically. Staff have more freedom in that they have a supported environment in which they can place their materials and information and for the more adventurous EEMeC has acted as a stimulus and opportunity to experiment and develop new forms of technology-supported teaching and learning. Administrators have more freedom as they can send notices, post documents and add and check logistics such as timetables, assessments and coursework submissions easily and quickly and can do so from a central authoritative source. Freedom is a relatively individual characteristic so while its relevance to the MBChB programme is low its cumulative individual affordances rate it as relatively high.	4.5	2
	-ve	There has been a degree of homogenisation of practice around EEMeC, which has meant a few academics have had to change their practices to meet the new norms being established around EEMeC functions – such as the Portfolio and the noticeboards. Administrators must present information to EEMeC in a timely and properly formatted way and in that respect they have less freedom of approach in their work.	1.5	
granularity	+ve	EEMeC has allowed for a wider range of activities (such as peer assessment and asynchronous discussion) are possible thereby adding to the complexity of available means of communication and teaching and learning. Many administrative tasks have become simpler and faster reducing complexity or have finer degrees of control and process that might increase complexity of such administrative processes. It has been the case on a number of occasions that rendering an activity or workflow in EEMeC has introduced greater clarity and transparency to that process by requiring clear, logical and reproducible activity structures	3.5	2

		and a greater degree of documentation and a move from tacit to explicit knowledge and practice.		
	-ve	EEMeC has added little complexity to the MBChB as it was already very complex before EEMeC started. EEMeC has however required individuals to pay more attention to the accuracy of their information and the way it is handled. Although this is beneficial overall it has sometimes been criticised as increasing staff pressure and stress.	0.5	
interaction	+ve	Both the quantity and the quality of interactions between staff and students are greatly improved by the noticeboards, timetables, assessment results, portfolio and many other tools and services. In particular, the use of EEMeC has enabled students to discuss their studies and related issues openly and publicly in the discussion boards and to help each other with problems.	5	3
	-ve	There is no evidence to suggest that students are interacting any less face-to-face as a resu7lt of EEMeC as many of the non-academic discussions are about social topics like meeting in the pub and going to parties, films or concerts. There is a possibility however, that as discussion moves online it may displace direct interactions.	0.5	
pedagogy	+ve	Using EEMeC has led to the introduction of new teaching and learning opportunities such as those afforded by online discussion, CAL resources, group project work and online assessment. However the uptake of these opportunities is patchy and as such the impact is less significant than it might be. Some teaching practices such as jointly authored websites, peer assessment and aspects of evidence based medicine are wholly dependent on EEMeC.	3	2
	-ve	Time spent on EEMeC activities is time not spent on other things. It is not proven that students suffer from spending a lot of time online (actually the opposite seems to be more likely) but there is a possibility that students are distracted by EEMeC use. Several staff have also levelled the criticism that EEMeC tends to make students' lives too easy 'handing them everything on a plate', thereby reducing their development of self-management skills and autonomy. There is no immediate evidence for this but it should be considered as a distinct possibility; certainly students seem to be very strategic in their patterns of study.	1	
resource	+ve	Both time and money has been saved by course and year organisers, administrators and teachers in general. This has been by saving on printing costs (in particular for evaluation forms, lecture notes and the portfolio), time (through the speed and ease of communicating with students and through the efficiency of information processing tools such as those used for evaluation, assessment and coursework submissions).	5	3
	-ve	The cost of developing and running EEMeC was about £400,000 between 1999 and 2004 (see chapter 4, table 4.5) and although much of that was covered by external funding for other work or from accumulated funds, the expenditure could have gone elsewhere, for instance to employ teaching or administrative staff. As much of the original funding has now gone there are serious questions to be asked about EEMeC's long-term survival and future. Furthermore EEMeC, like any computer system, will not last forever. Indeed EEMeC is in a constant state of redesign and redevelopment. This represents an	3	

		ongoing cost, particularly in terms of staff time. In addition to staff and development costs, student costs have increased in as much as they now pay for printing of lecture notes and other materials which (if provided at all) would previously have been paid for by academic departments.		
politics	+ve	Students have more power in commenting on and influencing events by using the discussion boards and the expanded and more reflexive course evaluation introduced by EEMeC. The tendency for students to use the discussion boards to stage protests and other group activities has increased over the years. A major change with EEMeC is the presence of a new professional group in the MBChB matrix: learning technologists. Before 1999 there were none involved, whereas now there are learning technologists on many of the MBChB's committees and they are involved in shaping the teaching and learning environment in many different ways. From a positive point of view this brings new blood and fresh perspectives to teaching and learning; certainly the EEMeC team have been at pains to enhance and support the MBChB wherever possible.	3.5	1
	-ve	On a negative side the increasing power of students and the arrival of learning technologists has diluted and changed the previous power structures within the MBChB. For instance EEMeC staff are now involved in operational decisions about the disposition of the MBChB.	1.5	
distal	+ve	EEMeC has won prestige and acclaim from outside the University and it has enabled the EEMeC development team to undertake other projects on the basis of the reputation and skills built up from developing EEMeC. EEMeC has also functioned as a symbol of the quality of Edinburgh's medical education and as such has been used by many others both to discuss change and innovation and as a vehicle for publications, research and other distal activities.	4	2
	-ve	Within the University EEMeC has sometimes been seen as a distraction, a throwback and an indication of the bloody-mindedness of medics who have often been criticised for claiming 'we're different' and going their own way, often in opposition to the rest of the University.	1.5	

Table 9.2: AIDA evaluation of EEMeC's development and impact on its context of use. Positive and negative effects are recorded for each of the seven AIDA factors and a rating given for the degree of impact of each one. This is combined with a weighting factor to indicate the relative importance of the factor with respect to the others. The resulting data is shown graphically in figure 9.1.

This evaluation was based on interpreting the historical evidence cross correlated with the other data presented in this thesis, in particular with interviews with staff from chapter 10 (see appendices 10.1-10.3). The analysis was performed using a single evaluator (the author). An ideographical approach such as this is clearly open to bias, subjective variation and partiality on behalf of the author. A more appropriate methodology would have been to get multiple evaluators to rate the system and then to present the results in a probabilistic framework. The availability of staff time to undertake such tasks was limited and had already been employed in other analyses (including the piloting of the AIDA instrument) and was not therefore available to undertake parallel AIDA analyses. The use of AIDA to consider other learning technology interventions in other settings is under way but falls outside the scope of this thesis. The absence of any y-axis scale on figure 9.1 is a response to the partiality of the approach taken as it is solely intended to provide a representation of the relative impacts of the seven factors rather than any absolute measure.

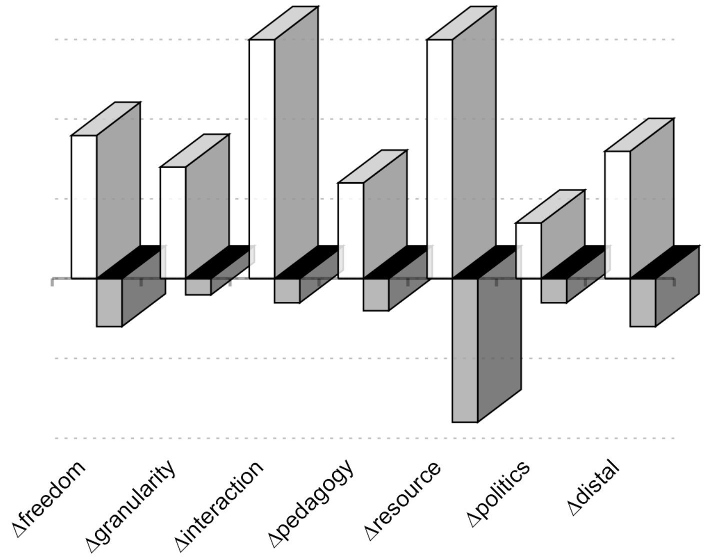

Figure 9.1: graphical representation of the AIDA scores for EEMeC as shown in table 9.2. The AIDA evaluation of EEMeC shows positive impacts overall with improvements in interactions and resourcing as the largest gains, with pedagogy receiving only a relatively low-level positive impact. The largest negative impact has been the degree of resource required to undertake the project.

To supplement the AIDA evaluation Rogers' typology of change and diffusion factors (Rogers, 1995) were also used as a means of evaluating how EEMeC has changed over time; the results of this are shown in table 9.3. Note that this approach is relatively narrative-based compared with AIDA and it is structured around relatively non-congruent criteria. Despite this it is a useful structure around which a historiographical narrative can be based.

Factor	**Description**
Relative advantage of EEMeC	This factor can be interpreted in two ways; how did EEMeC improve on the situation before such a system was used, or how does EEMeC's ability to support the current situation compare with the alternatives (other VLEs or no VLE at all). Neither answer is straightforward, but the perception of advantage is more important than the actuality.

	The relative advantages of EEMeC over the MBChB pre 1999 are particularly hard to evaluate as EEMeC was introduced at the same time as, and indeed to support, a major change in the way the MBChB was structured and run. However the perception of those who commissioned and subsequently used EEMeC was (and continues to be) that EEMeC was a very distinct improvement over the alternatives (see interviews in appendices 10.1-10.3).
Compatibility of EEMeC	EEMeC was built from within the MBChB to be a fundamental part of it, as a result it is as compatible as it can be made to be at any given time. Certainly development processes that engage with user communities are more likely to minimise problems between individuals and the tools they use (Friedman and Kahn, 2003). However this does not mean that a VLE that has been very closely aligned to its use context is completely compatible with all aspects of that context. EEMeC's development is an open-ended process and there are many ways in which it could be made more compatible. EEMeC's compatibility with its context of use was covered in chapter 5 and its compatibility with the community of practice it serves was covered in chapter 7.
Complexity of EEMeC	There have been different kinds of perceived complexity reported by EEMeC users; the complexity of finding things, the complexity of using specific tools and the complexity of the system as a whole. Both student and staff users report difficulties finding information from time to time, most often because it is not where or what they were expecting it to be. EEMeC, as a system based on the hypertext models of the web, could have many more links and ways of finding things but these would take more time and effort to establish than has been available for such a task. The establishment of the nodal architecture made finding information easier as the search facility was introduced as part of the system (see interviews in appendices 10.1-10.3). EEMeC's tools have been designed from a very user-centric point of view and as such the complexity associated with using them is low. Some staff training has been required but this has tended to be as much about gathering and reviewing user requirements as about teaching individuals new skills or techniques. Students have been given introductory sessions on EEMeC as part of their induction. This has been essentially to inform and orient students as to the purposes and ways of using EEMeC rather than teach them skills. There has been no requirement, perceived or requested, to provide students with any specific training on how to use EEMeC. Regarding the perceived complexity of the system as a whole, staff have tended to perceive it as having great complexity while students have tended to perceive it's complexity as not being a particular issue. This is in part because EEMeC's more complex tools are intended for staff rather than students. Staff have responsibility for the teaching and administration of the MBChB and therefore feel greater responsibility for the system (providers rather than customers) and because staff have displayed significantly lower confidence in their skills and understanding of web-based systems and working than students. Note that complexity was also addressed as an idea in the previous chapter where EEMeC's requisite variety was identified as matching that of the MBChB very closely.
Trialability of EEMeC	In one sense, because it was built from scratch and from within the MBChB, EEMeC couldn't be trialled until it had been built. On the other hand EEMeC's development has been trial-based throughout with components migrating to full service only as and when users are confident that the subsystem performs as they would wish. However the complexity of certain settings and functions has meant that trialling and testing the system before use has been impractical. Where this is the case trialability has been low. A key example of this has been the Assessment Engine, which, because there are so many factors involved, could only be tested against real settings

	and real data in actual use. EEMeC has also been reported as providing opportunities to staff for trialling of new teaching techniques (see interviews in appendices 10.1-10.3), in both electronic and face-to-face arenas. EEMeC can therefore be said to afford trialability as well as being trialable in its own right, indeed the format may be of greater importance and have a greater impact on the MBChB in the long run than the latter.
Observability of EEMeC	The observability of EEMeC takes three forms; the observability of the system before adoption, its observability to its immediate users (both actual and potential) and its observability to those outside the MBChB. The former factor was impossible as not only did EEMeC not exist but also its commissioners, users and developers alike had no prior experience of using such a system. EEMeC's observability to its users has been a major force for adoption of the system as many teachers have enquired and adopted EEMeC only after observing colleagues using it successfully. Such is the perceived observability that users now apologise for not using EEMeC more (such as one of the validators of use case scenario 13 in appendix 6.1). In particular it is students who have acted as one of the strongest forces for adoption on individual members of staff; they observe how other 'early adopter' staff use the system and put pressure on those who are not using it to adopt the same approaches as those who do. The observability to an external audience has two forms; direct and indirect. Because EEMeC is password protected only those who have legitimate roles in the MBChB can get access to the system directly, and more importantly, meaningfully. Even guest users have problems understanding what is going on in EEMeC without the other dimensions of participation in the MBChB to give it context and meaning. Both of these factors render EEMeC's direct external observability virtually non-existent. Indirect observability is very high as the system is often seen as a 'gold standard' approach. As a result there have been many requests for EEMeC to be made available to others. Some of these have been met (for instance in the creation of EEVeC, EEPoP and eScript) while for others, without a formal relationship with the EEMeC development team, such requests have been turned down. The frequency of non-College staff and students requesting an EEMeC service for their particular programme has caused political tensions between the College's development team and the University's central provider of VLE services, MALTS on several occasions.
Participant homophily or heterophily	There are a lot of different participant groups in EEMeC; students, science teachers, clinical teachers, administrators, other support staff, and distal actors (such as those in the University's computing services and registry, and in Edinburgh's NHS partners); all of which pre-existed EEMeC. The major change has been the arrival and growth in prominence and power of the learning technologists that have designed, built and run EEMeC. As a team these developers are quite homophilous in that there is little specialism and generalist and team-working have been its most important characteristics. There have however been occasions of marked heterophily between the development team and MBChB staff. This has occurred when users have been unable to express their needs to developers or their needs have been misunderstood or misinterpreted, or when what seems like simple requests from either party are in fact very complex and/or controversial for the other party to meet. Despite this efforts have been made by both parties to work more closely, and as a result EEMeC's developers have become more homophilous over time.

Adoption decisions	*Optional innovation-decisions:* students participating in discussion, use of self-study materials such as EROS-based CAL materials. Staff placing lecture and practical materials on EEMeC and using EROS for authoring CAL materials. *Collective innovation-decisions:* social and collaborative use of discussion boards, group and project work and other collaborative approaches. EEMeC team development process. Strategy of 'EEMeC and only EEMeC' there is no compunction to use EEMeC on staff; although a number of previously external sites have been absorbed into EEMeC (usually by offering an improved and enhanced service and support), they could have continued outside EEMeC. *Authority innovation-decisions:* Students are required to refer to their timetables, access assessment results, submit coursework, check noticeboards and a number of other tasks on a regular basis. Staff are required to provide adequate and accurate information and resources in time and in the right format for placing on EEMeC.
Innovator-laggard distribution	Innovators: EEMeC developers, key MBChB managers Early adopters: students, experimenters and innovators among academic staff Early majority: students, year secretaries, year and module organisers Late majority: teachers, general administrators Laggards: clinical teachers, particularly those with little direct engagement with the MBChB. Some clinical teaching staff have honorary contracts with the University in respect of their teaching, while others have no formal relationship with the University. It is this latter group who are least engaged with EEMeC.
Consequences	*Desirable consequences: r*educed costs in terms of staff time and resources (such as printing and document storage), enhanced quality and efficiency of teaching and logistical support, opportunity and stimulus for innovation, experiment and development of teaching and learning, the creation of a blended learning environment employing the best of online and traditional techniques, increased student-centred and devolved approaches to learning. *Undesirable consequences*: provision of inaccurate or misleading information, some factionalism, maintenance of very large information sets can be complex and sometimes unwieldy. *Anticipated consequences* Communication and coordination improved, saving of time and money in key areas, opportunities for innovation and development created. *Unanticipated consequences*: student power and activism, distal profile of excellence, adoption of discussion as major component of the social learning styles adopted by the student body. Note that a range of potential and actual undesirable and unanticipated consequences of developing and using EEMeC were discussed in chapter 8.

Table 9.3: description of EEMeC adoption and development against a range of Rogers' innovations criteria (Rogers, 1995)

9.5: Discussion

Histories are inevitably written from a subjective point of view; the historian provides a window on the past, filtering out some aspects and emphasising others. In that respect any historical analysis is going to be qualitative and interpretive rather than purely objective, being:

> *"an act of reconstruction undertaken in a spirit of critical inquiry designed to achieve a faithful representation of a previous age" (Cohen, Manion et al., 2000, p158)*

Because the evidence for the historical analysis is primary, and has in some instances been additionally validated by EEMeC participants, it is of acceptable quality for analysis. Because the evidence is essentially textual the analyses are essentially historiographical (Tuchman, 1998).

A number of different approaches to historical analysis have been pursued. For example, using Perrolle's typology of change (Perrolle, 1987, pp32-34), the development and use of EEMeC has marked a period of mixed dynamic stability and structural change. Although change has been a constant factor, there has been no revolutionary or catastrophic change associated with the use of EEMeC. In particular, while the MBChB has not changed overall, there are aspects of 'structural differentiation' and 'social integration', in particular regarding the introduction of learning technologists to the professional mix. Alternatively, using Morgan's models of change, EEMeC and the MBChB have demonstrated signs of autopoietic behaviour by not using the opportunities for change and reinvention that the introduction of a VLE could have helped to be brought about. In this respect the use of EEMeC has in many ways been quite conservative reflecting evolutionary rather than revolutionary change. The attractor of online communication has moved the MBChB from a stable phase of limited traditional forms of interaction between participants in the MBChB to one of extensive electronic interactions, particularly between students. EEMeC's move in to new areas of programme activity may have been opportunistic in many ways but it has rarely if ever been serendipitous. Lastly there are a very great many contradictions in VLEs, and EEMeC is no exception. Chapter 11 on analysis will deal with these contradictions and their dialectical resolution.

The use of the AIDA framework provided a more comprehensive review of the impact EEMeC has had on its context of use over time. While the greatest range of change was in respect of resources, the greatest positive change was in the area of interaction. Changes to pedagogy, perhaps the main purpose of a learning environment, were among the smaller factors rated. This latter point stresses both the multifactorial ways that a VLE interacts with its context of use, and the fact that the Edinburgh MBChB remains a predominantly face-to-face programme of study. The use of Rogers' change criteria provided a complementary perspective to that of the AIDA analysis and an enhancement to the historical evaluation of EEMeC as a whole. Factors such as trialability and observability added important extra dimensions as did decision and consequence models.

EEMeC has changed greatly over time, from being a course website to a complex content management system, an online collaborative working environment for staff and a substantial extension of the learning environment for students. To talk about EEMeC as if it were a single and constant entity over time is therefore misleading. The way EEMeC has changed and the stages of its development should be factored in to any other analysis. The log analyses in chapter 4 for instance should be qualified by the changing nature of the system that is being logged. As regards the validity and utility of a ‘flux and change’ perspective, it is clear that this is an essential part of a VLE’s evaluation. Furthermore it has been shown that any such analysis should cover both the VLE and its context of use. Having said this, the absolute impact that the use of EEMeC has wrought on the MBChB is hard to quantify against a background of many changing factors, introduced as it was at a time of great change in the MBChB as a whole.

No solution is a final or absolute solution; all technologies are in effect stop-gaps. In the same way that living entities have lifecycles, so do all technologies, some lasting longer of shorter than others. All technologies are essentially intermediate, computing technologies in particular. EEMeC is changed and developed from one day to the next, and like any other system it will sooner or later be replaced, either from within by changing one component after another (like a body replaces its cells) or by a successor, or if the context changes significantly then by something quite different.

The impermanency of technology in general means that any VLE can never be any more than a staging point. Furthermore, the study of a VLE’s history shares many aspects with industrial archaeology; rarely does one technology go without leaving a trace, either on the technologies that supersede it or on its environment. In this respect a VLE can be seen as palimpsestic; something that bears the traces of the entities and practices that preceded it. The ‘industrial archaeology’ of VLEs and tracing the echoes of their antecedents in the current form and function would be another area deserving of further investigation.

Chapter 10: VLEs as Political Systems and Instruments of Domination

10.1: VLEs, Politics and Domination

This, the last of Morgan's metaphors, concerns the ways that organizations can be modelled and evaluated as systems of power and authority. In particular this metaphor is concerned with the ways in which the interplay of the divergent needs and interests of the participants in an organization achieve some kind of order. Organizations can be seen both as forms of government (emphasising authority, democracy/autocracy and leadership), and forms of political activity (emphasising different interests and identities, power, conflict and its resolution, and control) (Morgan, 1997). Political aspects of organisations also reflect their non-rationality, reflected in bureaucratic rules and procedures, internal factions, and dependence on serendipity (Weiss, 1988). This is every bit as true for information systems as it is for organizations (Mander, 1994; Knights and Murray, 1997). Not only is technology inherently politicised, but the politics of technology are essentially dynamic and fluid and they should therefore be evaluated as such.

From this perspective the political analysis of a VLE (as a form of technology) is a valid approach to take. Checkland identified the analysis of the power dynamics of a system as a requirement of a soft-systems approach (Checkland, 1981) and soft systems methodologies have subsequently been identified as an essential means with which to consider the VLE problem space (Koper, 2000). A methodology for the political evaluation of VLEs should also take in to account the divergent, and potentially conflicting, interests of those involved and it should situate the evaluation in the reality of the political makeup of a VLE's context of use (Knights, Noble et al., 1997).

There are many issues raised by taking power and domination as a theme for the evaluation of VLEs. The two methods adopted by this chapter are the creation of an ideographic description of the groups and factions operating within the VLE's context of use and a second account of the way in which the VLE can act as an instrument or medium of control and power within that context. This was operationalised by the conducting three guided interviews with key staff involved with the Edinburgh MBChB, and correlating their responses with other extant data (such as the free-text responses from the Learning Architecture Framework evaluation described in chapter seven) and with the author's own knowledge and experience in working within EEMeC's context of use.

10.2: Power Dynamics in a VLE

There are two stages of analysis of power dynamics that need to be considered when evaluating a VLE, one of which must precede the other:

- *The power dynamics of the context of use*. Unless a course is explicitly designed around a VLE from the outset then the existing political makeup and interactions in the learning environment into which a VLE (or any other technology or system) is introduced must be considered as a precursor to any analysis of the impact or effect the use of the VLE has upon the politics of that environment.
- *The VLE as a change agent or medium for political expression*. Having established the political makeup of the learning environment as a whole, questions such as 'has the introduction of the VLE changed the political dynamics in the learning environment?' or 'in what way is the VLE a medium or tool by which power is exercised?' can then be asked.

Mainstream political analysis has been identified as falling in to one of three schools (Tansey, 2004, p7); the ideographic approaches of traditional scholarship focus on individual interpretations of specific situations, whereas political science uses statistical approaches to create general political theory, and radical criticism takes an essentially reflexive approach as it questions the assumptions and norms of the researcher as well those of the situation being studied. Although political science may provide appropriate methodologies for a broad review of many learning environments or the use of VLEs across many use contexts it is an inappropriate technique for a single context study such as undertaken within this thesis. The alternative is therefore to use ideographic techniques and incorporate reflexive criticism where appropriate. This is essentially a critical ethnographical approach (Cohen, Manion et al., 2000, pp153-155).

10.2.1: Methodology

To operationalise an evaluation of EEMeC from the perspective of power and domination a number of basic questions need to be answered: 'who is involved?, 'what has happened and how did things get like they are?' (covered in chapter 9), 'what is happening now?' (covered in the use case scenarios in chapter 6), and lastly, 'is the VLE an instrument of power?'. As two of these questions have already been covered elsewhere in this thesis, there are two remaining studies that need to be completed. First of all, an analysis of the parties involved, their motivations, their relative influence and their responsibilities was taken based on the author's observation and participation in the use context. Secondly, interviews were conducted with a number of EEMeC staff and managers. The number of such staff is limited and so one each of a programme manager, a year organiser and a module organiser were selected and taken through a guided interview. The starting questions around which the interviews were structured are shown in appendix 10.4. The interviewer was the author and the interviews were audio recorded and subsequently transcribed. The interviewee responses were edited for pauses and false starts on sentences but are otherwise recorded as spoken. There are transcripts of the three interviews available as follows:

- Interview 1: Year Organiser (YO) – see appendix 10.1
- Interview 2: Course Organiser (CO) – see appendix 10.2
- Interview 3: Programme Manager (PM) – see appendix 10.3

Ideally this approach would also have included student perspectives as a contrast to those of the staff members. However, although the author made a request (via EEMeC) to the student community for interviewees there were no volunteers forthcoming, and as this was one of the last parts of the data collection undertaken for this thesis, student perspectives were not available.

10.3: The Political Makeup of the VLE's Context of Use

When the politics and overt controls of a learning environment (virtual or otherwise) are our focus then there are a number of aspects that can be evaluated including the political makeup of the learning environment and the ways these groups interact. Within a typical learning environment the following groups are the main players:

10.3.1: Students

Students are the main focus of any learning environment. The student's role is to work through the tasks assigned to them, to pass assessment barriers and to ultimately achieve a degree (or some other award). Student motivation is typically related to improving employment prospects and opportunities and to engage in a range of social activities. Students tend to organise politically, for instance through societies and student unions, to improve their lot, but generally they submit to the regulations and procedures of the learning environment in order to achieve a qualification at the end of their studies. Non-compliance may lead to exclusion from a course or programme of study. Furthermore, students are different from the other players in a learning environment in that all the other participants are employees of the institution or its affiliates. In certain circumstances lay members of the public may also be involved such as pupils in teacher training or patients in medical education. However it can be argued that these players effectively function as resources rather than as active participants in the learning environment.

There were 818 female and 460 male students on the MBChB or undertaking intercalated honours as of January 2005. By domicile on entry, 470 were Scots, 657 were from the remainder of the UK, 33 were from the rest of the European Union and 118 others were from overseas. Between 5%-8% of entrants do not complete the MBChB programme (source Edinburgh Student Records).

Cohort	*Number of Students*
Pre-Medical Course	5
Year 1	231
Year 2	241
Intercalating Students	83
Year 3	256
Year 4	229
Year 5	241
Total	**1286**

Table 10.1: Student numbers in the Edinburgh MBChB, January 2005.

Students have a lot of power in some ways but very little in others. Student representatives are elected in each year in each academic session to represent student interests in the MBChB. Their participation is actively sought for most of the formative committees and groups that meet to run and develop the MBChB. In addition there are frequent staff-student liaison meetings and there is a Medical Students' Council that meets to consider a wide range of issues affecting the medical student community. In addition to these formal channels of student feedback and participation in the programme individual students have their say on their experiences throughout the MBChB by providing feedback through the course evaluations.

The introduction of EEMeC has influenced and changed the dynamics of power and control for students within the MBChB both as a group and as individuals in some of the following ways:

- Students are able to, and indeed do, continue to remain in contact with the MBChB outside of 'office hours' (the server logs shown in chapter 4 show this clearly). This has had the effect of empowering students to follow patterns of study that are suited to their personal choices and circumstances. However lectures, practicals and clinical attachments are still scheduled 9-6 during the week so the effect has been to extend rather than displace the opportunities for contact and engagement with the programme. Although a number of academics, and on occasion academic managers, have expressed concerns that EEMeC may act as another reason for students to not attend lectures there is no evidence to support this concern. The corollary of the increased ability to engage with the MBChB over time is that students' ability to distance themselves from the MBChB is reduced. For instance they are required to check notices daily and their logins are reviewed when they claim not to have seen a certain notice. Certain staff users can also check students' portfolio submissions, their selection of projects, their peer assessments and many other points of interaction. The immediacy and abstracted nature of EEMeC's ability to present information both to and about students has changed the power dynamics in the MBChB by extending student's ability to engage with course whilst at the same time increasing requirements on them to so do and enabling their actions to be monitored.

- Through EEMeC students have possibly become more dependent on having certain information always available to them. In the free-text responses to the LAF questionnaire (covered in chapter 7 and shown in full in appendix 7.4) many respondents note frustration with the absence of timetables and lecture materials. That EEMeC has relatively greater 'use density' in the early stages of the programme potentially exacerbates this. Certainly there have been concerns expressed that as the information and support given by EEMeC reduces in later years students are left with less:

  > *"EEMec started off well, providing individual timetables and all the info we needed at the beginning of 3rd year. The usefulness decreased throughout the year with no more timetables and less info, or the wrong info, now in 4th year for much of the time the individual timetable has not even been active, and has nothing on it anyway, EEMec is now only useful to see what everyone is moaning about on the discussion boards, and occasionally to get important notices from faculty on the noticeboard..." Year 4 student comment from LAF questionnaire – see appendix 7.4.*

  Students also report frustration with being given misleading information or it being absent altogether. This is particularly the case when it leads to their turning up to timetabled events at the wrong time or to the wrong venue. The power to both direct and misdirect students gives EEMeC, and therefore those that use it as a conduit for giving these instructions, significant power over students. However this power is tempered by the confidence of the students in the accuracy of the information given.

- EEMeC has increased the opportunities for student participation in and awareness of the way the course is managed and developed. For instance moving the course evaluation in to EEMeC has meant that all of the evaluation reports are made available to the community along with commentaries from year/module directors about how issues raised are to be addressed. Minutes of staff student liaison meetings are also provided via EEMeC and there is a page for and about the student representatives and the Medical Students Council. One of the main ways that EEMeC has changed the political dynamics of the MBChB has been the student use of the discussion boards for raising issues and organising protests. The increasing use of the boards for this kind of activity has occasionally been described as rabble-rousing by some members of staff but it has also led to many more members of staff checking the boards for problems or signs of unrest than was previously the case. The discussion boards also give students power over each other by giving any individual the ability to complain about any other student's postings, although inappropriate complaints can also be penalised. There have been one or two complaints that the student majority view on the discussion boards can drive out dissenters but the strength of multilateral debate often found on the boards would indicate that this is not necessarily a major problem. EEMeC has also permitted much greater visibility of student activity than before. Although this can be seen as invasive it also increases the impact of their words and actions.

- Students can, and have, influenced the development of EEMeC, both positively by suggestion and negatively by complaint. The likelihood of this kind of influence is more likely to have effect when presented by a number of students or when it is raised in the context of staff-student liaison meetings. A lot of student influence has been focused on teachers to use EEMeC, especially for providing materials in relation to lectures, practicals and other teaching sessions. This is partly due to the fact students are much more engaged with EEMeC (and the MBChB) than most teachers and that students seem to be relatively confident and competent with web technologies with respect to staff.
- Students are also seen to be helping each other by suggesting solutions to problems, discussing difficult concepts or participating in reflective discourses in a relatively public way, marking a move away from a student culture of competition.

In general, MBChB students are compliant with the requirements of the MBChB programme. They are also active participants in the running and development of the programme as a whole. The introduction and use of EEMeC has increased opportunities for students to participate in the programme while at the same time making their actions (or the lack of them) far more visible to those running the MBChB. The discussion boards in particular have provided the means for greater political activity, public reflection, problem solving and mutual support. Students have also been a major driver for teachers to use EEMeC and have contributed a significant number of additions and changes to EEMeC over the years.

10.3.2: Proximal Members of Staff

There are many different staff groups directly involved in the VLE's context of use:

10.3.2.1: Teachers

Teachers are the educational facilitators, designers and assessors of the learning environment. They design courses and the events in them (lectures, practicals, exams etc), they run these events and they assist students' participation in them. In most universities in the UK at least the majority of teachers will hold academic posts that will require them to undertake a certain amount of research, postgraduate teaching, administration and other duties. A teacher's motives will most likely include seeing their subject taught well and appreciated by their students and peers and meeting their other duties while at the same time continuing in employment, increasing status and financial gain, and all with as little effort and stress as is required to get their tasks done to their satisfaction.

In the MBChB there are at least five kinds of teachers:

- Scientist-teachers: much of the teaching in the first two years of the MBChB is performed and organised by academic members of staff from a medical science background. These individuals are full-time University employees and are mostly affiliated to one of the main disciplines of anatomy, physiology, microbiology, pathology, genetics or neuroscience. A subset of the scientist-teachers is that of the sociologist-teachers who teach aspects of the MBChB such as public health, medical sociology, epidemiology and health statistics. As professional scientists, research is often their primary responsibility, and teaching may only be second or even third on their list of priorities; only a small number of scientist-teachers are involved full-time in teaching. These individuals' primary allegiance is to the (subject/discipline-focused) department (or more recently school or division) and they are predominantly subject to its political dynamics rather than those of the MBChB. Although biomedical sciences are largely concentrated in the earlier years of the MBChB, scientist-teachers are increasingly being asked to contribute to teaching in later years. Although these teachers have strong research and departmental influences on their working lives, they are, as members of medicine-related schools, proximal to the MBChB teaching and subject to the same general university forces. As such they are more likely to be aware of and make use of EEMeC than their clinician colleagues.

- Clinician-teachers: the final three years of the MBChB are organised, and mostly taught, by academics whose main responsibilities are performing clinical duties within the NHS. Those staff with any more than a passing involvement in the MBChB are most often on 'honorary' contracts with the University in that they are contracted to perform a certain number of hours of teaching per week. Their main working context is the GP practice or hospital department in which they provide clinical services for the majority of the time. In additional to the honorary teaching staff there are many other NHS employees who are involved in contributing to the MBChB learning environment. These might include trainee doctors, nursing staff, or administrators. The Additional Cost of Teaching (ACT) funding, paid to the NHS in Scotland by the Scottish Executive, is intended to offset the cost to the NHS for accommodating teaching of undergraduates in its premises and by its staff. The EEMeC evaluations are run as part of the ACT monitoring process. Clinician-teachers are relatively distant from the MBChB and the University and as such are less likely to be aware of or use EEMeC than their scientist colleagues:

  "clinical staff are less aware of how to access Eemec to communicate with students" Year 5 student comment in LAF questionnaire, appendix 7.4

- Non-academic teachers: although they are relatively few compared to the numbers of scientists and clinicians involved in teaching medical students, these individuals are often quite 'visible' within the MBChB programme as they teach the vertical theme components such as clinical skills, computing and informatics, personal and professional development, and information skills. These individuals are often closely affiliated to the MBChB and many are members of the Medical Teaching Organisation. These members of staff often have a number of roles in the MBChB, only some of which may be directly related to teaching, and are often the highest users of EEMeC of any of the teaching staff groups.

- Distal subject teachers: these are those individuals who are brought in from outside the MBChB to cover very specific issues, often for single lectures or sessions and include hospital managers, defence union representatives, psychologists and social workers. These individuals, because of their peripheral involvement with EEMeC, are usually not given EEMeC access, or if they are it is often left unused.

On the whole, teachers hold significant levels of power in the MBChB although, as the medical curriculum is far more structured than that of most other subjects there is often as a result less autonomy for the teacher than for other subject areas:

> *"whereas in science I'm simply told 'can you give us a course on respiration' and it's left to me as an academic to decide what is appropriate for that level, what I'm going to teach and what I can fit into the lectures I'm given in the course I'm given; in medicine I am teaching to a menu. I don't think EEMeC in my interpretation of 'freedom' impacts on me either way" staff member – see appendix 10.2*

As regards EEMeC, teachers as a whole have most often been reactive rather than proactive and it has only been the 'early adopters' who have made substantial use of the system. This may reflect Crook's concerns:

> *"perhaps there is a (fatal) irony in asking teachers – a profession where self-assurance about what one knows and does is paramount – to incorporate a technology of such patent complexity" (Crook, 1994, p29)*

EEMeC has not significantly changed teachers' power within the MBChB in that they are still a necessary part of the learning environment and their practice has remained relatively unchanged despite now using tools like PowerPoint and placing some teaching materials online in EEMeC. For those that have wanted to experiment and develop new ways of technology-supported teaching EEMeC has provided both opportunity and support and in that way has been an enabling phenomenon:

> *"as a teacher it gives me access to innovative ways of presenting the material and it provides me with people who can advise on the technical side of accessing this electronic revolution. Otherwise as a non-techie person I would be wallowing in. So in that sense I think that what EEMeC provides the enthusiasts amongst the teachers with is the specialists to advise us and it allows us to use modern technologies for delivering the teaching" staff interviewee 2, appendix 10.2*

There are also issues of power associated with the hesitancy of more junior members of staff being reluctant to post messages in the student discussion boards.

> *"a number of them recently confessed that they did indeed look at the discussion boards but didn't quite have the nerve to answer some of the points raised. These were more junior staff and just didn't have the self-confidence to get involved." staff interviewee 1, appendix 10.1*

10.3.2.2: Academic Managers

Academic managers are those that design and manage whole programmes of study. In some cases they might be senior teachers, in others they might be fully employed to manage rather than teach a programme. Their motivation is to see a coherent and well-designed programme of study delivered with the minimum of trouble and as efficiently and effectively as possible.

In the MBChB the Medical Teaching Organisation is the central body tasked with the academic management of the programme. The MTO brings together the central managers along with the year and course managers and senior administrators to form the executive that manages the MBChB as a whole. This is the group who originally agreed to the proposal for EEMeC and it is the group to whom EEMeC is most accountable and from which EEMeC ultimately receives its instructions and has its functions sanctioned.

On the whole EEMeC has increased the power of this group to manage the MBChB by making information far easier to obtain and by meeting the various programme management requirements that have been made of it (see appendix 10.3).

10.3.2.3: Administrators

Administrators are responsible for handling much of the logistical and procedural aspects of a course or programme of study. They will typically manage timetables, look after room bookings, handle financial data and paperwork, perform record keeping, service committees and undertake a number of other clerical duties. Their primary motivation is to meet the business needs of the organisation. It follows that administrators often have a more vertically oriented working culture than academics, most often reified in more structured and hierarchical management. It is perhaps more appropriate to distinguish between clerical staff whose main tasks are in processing information and administrators who organise and manage these processes.

In the MBChB there are essentially two groups of clerical staff, year secretaries and College Office staff. The former are specifically attached to a single year of the MBChB and its academic organiser while the latter will have a range of responsibilities across the MBChB. It is the clerical staff that provide EEMeC with the bulk of its information and it is increasingly through EEMeC that much of the clerical staff's interactions with students take place. Problems occur regularly when inaccurate information is provided, when information changes rapidly (for instance at the start of an academic year) or when information is promised before it can be provided:

> *"there is often some discrepenacy as to when we are told by faculty that results will be made available on eemec and when they actually are available. This led last term to quite a lot of frustration for the O and g group and it would have been better to just let us wait rather than make promises day after day that were not achieveable" year 4 student feedback in LAF questionnaire (see appendix 7.4)*

As individuals, the clerical staff have relatively little power in the MBChB as they are required to undertake their work as directed and as efficiently and quickly as they can. Procedural rules and guidelines are often provided to guide them and significant effort has been dedicated both by EEMeC developers and by College Office to simplify and support better information processing for EEMeC.

It is administrators who do have significant power in the MBChB however. It was these individuals who were EEMeC's greatest opponents at the start of its development and their successors have more recently expressed concerns over the development and quality of EEMeC, mostly because of the quality of information it is presenting to the students. At the time of writing the senior MBChB administrators have commissioned a new online course administration system to improve the workflows and quality of information, both for themselves and for EEMeC. It is anticipated that this system will enhance EEMeC by providing better and more comprehensive information such as student listings and timetabling data directly without the error-prone manual handling which currently causes so many problems.

While clerical staff largely report being satisfied users of EEMeC, their managers have been less satisfied. This reflects the key issues that the administrators have responsibility for the business processes in the MBChB and are therefore cautious about threats to the quality of these processes. EEMeC, and those that design and run it, have effectively encroached on territory that has traditionally been held by these individuals, viz the control of information flows and the way information is represented to students and staff in the MBChB. Because central administrators removed themselves from positively influencing the development of EEMeC from its outset, the constructive alignment achieved with other user groups has been less forthcoming for this group. Accordingly this is an area in which administrators have potentially lost power within the MBChB to EEMeC, even though individual administrators may have greater control over their work by having direct access to the very same information and the means to manipulate it. The introduction of the new administration system, that will in part service EEMeC, have reified a process by which administrators have re-established control and ownership of this information and its associated processes. Thus, although a separate system is being established, it will both empower the administrators and improve the information flows to EEMeC and its users.

10.3.2.4: Other Support Staff

Other support staff include computing officers, librarians and lab demonstrators. These staff will spend only a portion of their time on any task that is directly linked to a particular course or programme of study and as such are relatively distanced from educational practices. Their motivation is to meet all of the requirements of their job and their managers and to do so as easily and simply as possible. These staff will use EEMeC occasionally but they have little influence on, nor receive much influence from, EEMeC.

10.3.3: Distal Members of Staff

In addition to support staff there are a number of distally related actors that have a role or impact on a learning environment. Organisational staff such as university managers, finance staff, personnel staff and members of other central bodies will create procedures and regulations that structure aspects of the learning environment. External bodies such as those that perform regulatory and funding roles will also have direct and indirect affects on the learning environment. In additional to the first two certain subject areas will also be open to influence from professional and political bodies. Within the Edinburgh MBChB internal parties include members of Computing Services, the Library, Registry and University central management. External parties include the Scottish Higher Education Funding Council (SHEFC), the General Medical Council and professional bodies such as the British Medical Association and the Royal Colleges.

10.3.4: Learning Technologists

In addition to the different staff participants in the learning environment listed in the previous section, the use of systems such as VLEs means that there is one additional group, that of Learning Technologists, that has been introduced to the learning environment. The essential role of this group was also identified in chapter 5. The role of learning technologist is a relatively new one and, in an ill-defined profession, a fluid one that is open to many different interpretations (Oliver, Frances et al., 2004). Even if the job title 'Learning Technologist' is not used overtly, technologists will have a central role in the way the VLE is shaped and run and thereby in how it is used.

Developers control the very essence of the systems they build. In this respect the developers of a VLE will have a fundamental level of power and control over the form and function of the VLE and thereby how it can be used. However learning technology developers have been identified as having quite different perspectives and interests from those for whom they are creating tools and systems (Hills, 2003). A VLE's developers may or may not have a direct relationship with their systems' users. This creates different kinds of responsibility and accountability. If a VLE is developed as a commercial product then the developers' responsibilities lie with their employer and their responsibilities with respect to the consumer (or client, purchaser etc) are defined by the contract and warranties associated with a commercial transaction. On the other hand if a system is developed within its use context then the developers' responsibilities and accountabilities are to that community context and are primarily about participation and mutuality. Power and control of technology use (expressed as autonomy) has been observed to be a significant concern:

> *"it is questionable whether choice over the purchase of technological artefacts alone is an adequate way of either theorising or exercising organisational autonomy … purchasing the package involves acquiescing in the pre-emptive 'choices' and knowledges of the supplier which are embodied in that package" (Scarborough and Corbett, 1992, pp21-22)*

Those that build the VLE may or may not be the ones who run it. Any complex application (including VLEs) will require maintenance and support over time and this will require a variety of tasks to be undertaken in order to accomplish this. These tasks may range from the purely technical such as server maintenance, though data entry and individual user support, to pedagogical and strategic management. The mix of tasks and the ways they are done will vary significantly between systems. While EEMeC has a core support team that performs all of these tasks, the WebCT setup in Edinburgh has different parties undertaking these roles; computing services do the server management, learning technologists do the user support and academics do the data handling and student support. On the whole learning technologists will often act as a VLE's gatekeepers and its brokers but the degree to which they are involved across the spectrum of support activities for a VLE depends on the context of use.

10.3.4.1: EEMeC and Learning Technologists

Different approaches to VLE system development were discussed in chapter 2, where three continua were identified: off-the-shelf and purpose-built; commercial and open source; generic and context-specific. EEMeC is completely off-the-shelf, mildly open source and highly context specific (see figure 2.2). This means that the development team for EEMeC is very close to its context of use. In fact they are all in the same organisational unit as the MBChB management team, the Medical Teaching Organisation (MTO).

The EEMeC team is part of the e-Learning Unit, which is part of the Learning Technology Section, which is in turn part of the Directorate of Undergraduate Teaching, and Learning, which sits within the College of Medicine and Veterinary Medicine at the University of Edinburgh. The organisation chart in figure 10.1 shows the organisational relationship of the e-Learning Unit relative to the other players in the environment.

Although it is a very crude approach, the organisational chart can be used to create an 'index of proximity' (IoP) between the EEMeC development team and other parties in the learning context. The IoP is the number of nodes between two entities in the organisation and is taken as a crude measure of how connected different parts of an organisation are with respect to each other. The IoP is derived from 'small world theory' (Watts, 2003) and 'network theory' (Lazega, 1997). The IoP for various staff groups involved in the Edinburgh is as follows:

- EEMeC team to IT Services IoP = 1. IT services are responsible for server support and are within the same section as the EEMeC team, and are very well connected.
- EEMeC team to MTO IoP = 2. The MTO academically manage the MBChB. Although they are separate from the Learning Technology Section both units are part of the same division and are quite well connected.
- EEMeC team to College Office IoP = 3. The College Office, which provides central administrative services to the MBChB, is moderately distant from the EEMeC team.
- EEMeC team to Schools IoP = 4. The Schools in the College are the organisational units to which the University-based teachers are attached and the EEMeC team is quite distant from this group.
- EEMeC team to Information Services Group IoP = 5. This is the central services group that provides library, learning technology and computing services to the whole university.

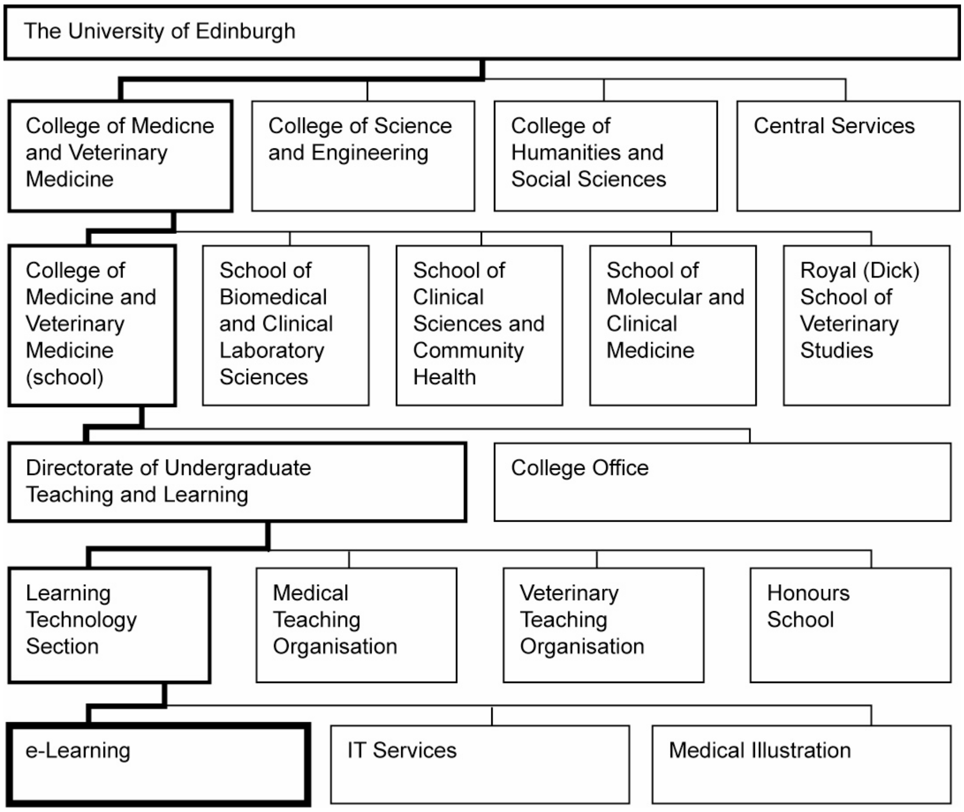

Figure 10.1: organisational chart showing the Learning Technology Section and its e-Learning Unit within the context of the University of Edinburgh.

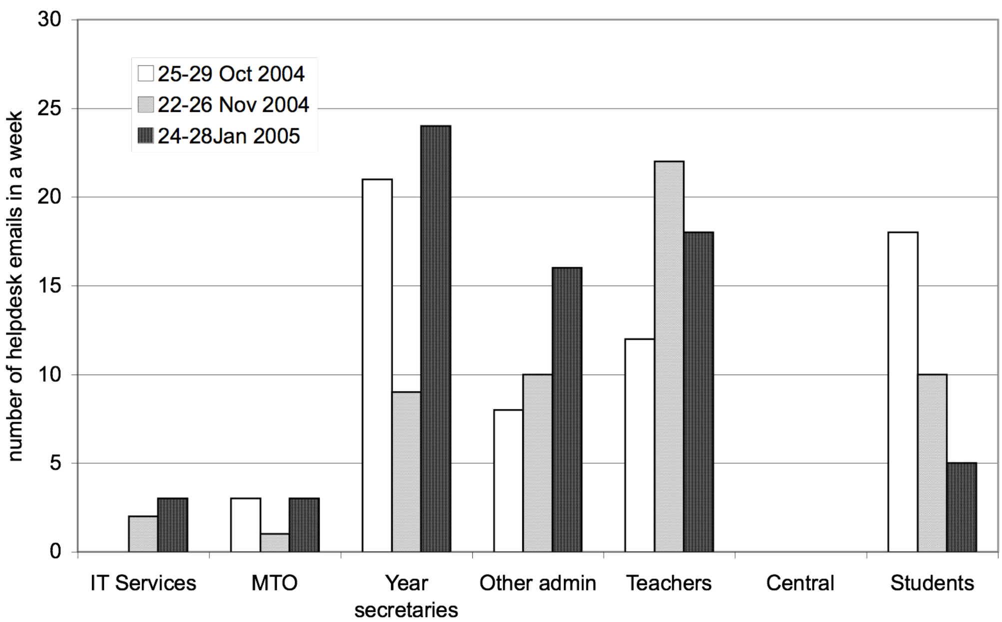

Figure 10.2: numbers of emails sent to the EEMeC helpdesk over a week for three different weeks in the 2004-2005 academic session.

Although the IoP is a crude measure, it is nevertheless an indicator of how connected the EEMeC team is to different parties in the MBChB learning environment. On the other hand, while the inverse of the IoP might be expected to be an indication of the frequency of engagement between the team and the linked entity this is not in fact the case. The majority of operational communication with the EEMeC team originates from the year secretaries and other administrators who are organisationally assigned to the College Office. The quantity of interaction is indicated by the amount of traffic sent to the EEMeC helpdesk email address.

Figure 10.2 shows the email traffic sent to the EEMeC helpdesk across three five-day periods during the 2004-2005 academic session. Although the pattern of submissions differs, the majority of traffic comes from administrators followed by teachers and then students. Interactions with members of IT services and the MTO are possibly more likely to be face to face than with the other groups but even then this would only add a few extra contacts to those shown.

The e-Learning Unit has nine members of staff, all on academic-related computing contracts. There is a Unit Manager, a Special Projects Manager and a video producer, all other posts are for learning technologists/developers. One member of staff works exclusively on a separate project while the other eight have lesser or greater degrees of involvement with EEMeC. Both managers and three of the developers spend a significant amount of time developing, running and managing EEMeC. While the manager takes many of the strategic development decisions, the special projects manager has a lot of responsibility for the day-to-day running and maintenance of the system.

The e-Learning Unit has retained a significant amount of autonomy by funding the majority of its posts from 'soft money', mostly from fees for external project and research work. This has made EEMeC economically attractive though at the same time dependent on non-MBChB resources.

Much of the way in which the development team has worked is recorded in the EEMeC histories in appendices 9.1 to 9.6 and in the use case scenarios in appendix 6.1 (particularly UC18). The team has both built and run the system from the outset and are involved in every aspect of its use. Members of the EEMeC team are assigned to different years to attend their steering meetings and are involved in a range of other MBChB committees and roles. Overall the team has become quite powerful as a result of EEMeC:

> *"LTS has probably become a lot more powerful because you're the gateway to getting things up there and making things happen. So the fact that we have more e-learning makes LTS much more powerful in the College because we've got to have you folks on board in order for it to happen. Things like online assessment make you terribly powerful" staff interviewee, appendix 10.3*

Although the EEMeC team has gained a certain amount of power in the MBChB it is still in a sense 'outside' the programme: although EEMeC's absence would be problematic medical education carried on successfully for centuries without a VLE! However along with increased power comes responsibility:

"mistakes happen, information gets lost, it's downright wrong so you folks probably have to shoulder a whole lot more responsibility having a VLE as opposed to just creating CALs" staff interviewee, appendix 10.3

When mistakes have happened with EEMeC it was the development team who were initially blamed when often it was the information provided that was wrong or some other issue not within the team's remit or responsibility. Information handling has had to be improved significantly as a result of using a VLE and the EEMeC team has spent a lot of time working, with year secretaries in particular, on staff development to improve the quality of information coming to EEMeC.

Early in EEMeC's development the occasions when human or technical errors did occur required a lot of explanation (and apologies). Although the apologies are still forthcoming on these occasions, the MBChB community has become markedly more sanguine about such problems, seemingly because they recognise that problems can occur anywhere and such problems that there are are sufficiently rare to be acceptable.

Irrespective of their influence and power within the MBChB, EEMeC's developers have joined the 'inner circle' of those with access to core course data and its associated processes. The burden of appropriate conduct and ethical behaviour is therefore much larger than for learning technologists who only have responsibility for the development and use of multimedia teaching applications. Those EEMeC developers that have been involved with issues of authority have themselves needed to develop the appropriate professional skills to handle these issues (Ellaway, Begg et al., 2005).

10.4: VLEs as Instruments of Domination

Having observed the political makeup of EEMeC's context of use and the ways EEMeC affects it there is one further major question that needs to be addressed: does EEMeC function as an instrument of political domination? Almost any technology may be able to be used as a means of dominating and controlling its users. VLEs in particular, because of the ways in which they span the learning environment, the ways they can be used to monitor activity and the ways they tend to assimilate activity and information, could well be used as instruments of domination. Land and Bayne have identified this concern within a similar context:

"the ethos of the [VLE] can be viewed in many ways as essentially managerialist. It is about order, efficiency, identified outcomes and control. The attraction of databases to the organiser of the [VLE] is not just their retrieval speed but their relational abilities and totalising nature … within such archival fixity and retrievability students will never be able to escape their past" (Land and Bayne, 2004)

Furthermore they have identified the potential for VLEs to have panoptic properties in that VLEs can potentially track and record almost every aspect of their users' online activities and then present that data to those who run the system, or use it to control the learning environment, without the knowledge of those users. The 'panopticon' was conceived by Jeremy Bentham in the 18th century as a model prison with cells radiating round a central observation chamber so that prisoners may always be under scrutiny but unaware when they are actually being observed. The panopticon has been adopted by Michel Foucault as a metaphor of unseen centralised monitoring and control of any kind (Foucault, 1975). Indeed there are many ways in which a VLE might function as an instrument of domination, including:

- Unseen observation and tracking of users
- Directing and regimenting by constantly providing rules and Instructions
- Contextual norms and conformance reified for instance in student discussion
- Centralisation of activity and information centralising control
- Totalitarian control or democratic participation

In order to evaluate EEMeC as an instrument of domination the guided interviews with those who run and manage the MBChB programme (described in section 10.2.1) were used along with evidence from other evaluations as an evidence base around which the following interpretations were drawn.

10.4.1: EEMeC as an Instrument of Surveillance

VLE tracking data can range from the triggered 'page view' or 'hit' of log files to purposeful user input. There is a particular problem with the former as there is no automatic correlation between a page being served and the user engaging with it in any way. After all, a strategic learner, knowing they were being tracked by their page views, could appear diligent by clicking through the pages of a VLE without paying any attention to what they contained.

EEMeC tracks users in some ways and not in others. Every point at which a user writes something back to the database is a tracked event. These include logging in, posting to the notice or discussion boards, submitting coursework and working through a CAL package. There is no page-by-page tracking nor is there a track of accessing tools that don't write back to the database, such as the timetable or the studyguides. This has been a deliberate design policy as there has been no need for any more tracking than this yet the accountability of user posts to any system is required by the University's computing regulations. The tracking data is only viewable across the system by the EEMeC development team. Some tools have been built around tracking information, such as the Portfolio which allows administrators to see who has and has not submitted coursework. The analysis tools in EROS allow the CAL author to see patterns of use without identifying individuals while the Evaluation tools completely anonymise submissions by tracking them quite separately from user data.

Land and Bayne have raised concerns regarding the potential for VLEs to reify aspects of a panopticon identified by Foucault (Land and Bayne, 2004). These properties include being observed without seeing the observer and partitioning the participants so that the system treats only individuals.

Land and Bayne in particular draw attention to the potential for the data held in a VLE about an individual to reconstitute and disperse them thereby changing the way they are perceived and treated.

EEMeC is panoptic in that data is captured and stored in the system 'hub' although very little of that data capture is unseen or secretive as it is mostly the result of direct and purposive user input. Furthermore, the MBChB management do not have direct access to the tracking information. In this respect the EEMeC team act as a buffer between the minutiae of the tracking and those who would make use of it. EEMeC certainly breaks the panoptic principle of 'lateral invisibility' as it affords, via tools such as the discussion boards, personal agency, mutuality, social learning and cooperation in particular among the student users. Although interestingly this also allows for mobs and other potentially negative reciprocal influences. Absence can often be as visible as presence. For instance students have often complained about the lack of staff engagement, which would only be possible if the students had a view on how much their tutors were using the system.

In the 'community of practice' evaluation described in chapter 7, EEMeC's ability to track student and staff was reasonably well thought of but was considered to be of little utility or importance to the user community in general, although it was of higher importance to staff than students (see figure A7.2.17 in appendix 7.2). EEMeC's users know that they are being tracked but this has not impinged greatly on their day-to-day activities except on the rare occasions when an individual has failed to meet a submission or has otherwise created cause for concern. In this respect the tracking data is not significantly different from that kept before the introduction of the VLE, the greater detail being used as a background record of who did what rather than a foreground system of surveillance. The way this works is covered in some detail in use case scenario 21 the 'Errant and Failing Student' in appendix 6.2. Another example is that although students are directed to attend events via the EEMeC timetable, there is no reciprocal register of attendance taken or stored in the system.

10.4.2: EEMeC as an Instrument of Conformity and Uniformity

There are a number of ways that a VLE could enforce conformity and uniformity in a learning environment. For instance it could express and reify rules and regulations, provide (and potentially enforce) instructions, algorithms and workflows, require individuals to normalise their practices or standardise the format and presentation of information and resources.

The pages for each year in EEMeC are based on the studyguides, which in themselves are full of requirements and instructions to students and there are specific directional tools such as personal timetables and the noticeboards. So in this respect EEMeC is a medium of conformity:

> *"[EEMeC] has probably put more power in to the centre in the way information is controlled and put out there and made public" staff interviewee 3, appendix 10.3*

Regarding norms and conformance the following was observed in reference to the discussion boards:

"there are certain norms that people have to conform to and I think they're quite clearly laid down in the discussion boards and the blurb that goes with them. In the first year those discussion boards got going they were rapidly stamped on when people went outside - and quite rightly so" staff interviewee 1, appendix 10.1

This is not significantly different from community interactions in other media, the differences being that the rules are more clearly reified and individuals can be held accountable for their contributions potentially long after they have been made. At the same time however, the opportunities that discussion can provide may also act against conformity:

"there's a slight informality about electronic communication that I quite like but which some members of staff might not like. I could see that it might lead to conflict with some members of staff who have a more formal view of what a student should and shouldn't say and do" staff interviewee 1, appendix 10.1

The student pressure on lecturers to post their teaching materials and partake in discussions on EEMeC is also an expression of conformity that relates to the VLE. Students have also welcomed EEMeC as a central point of contact in a changing programme, which is also an aspect of the VLE supporting aspects of conformity in the MBChB.

10.4.3: EEMeC as an Instrument of Authority

There are many ways that a VLE could act as an instrument of authority, and there are different ways in which that authority could be expressed. Examples include how much say users might have in how, when or where they were required to engage in the use of the VLE – there is no explicitly timetabled EEMeC time anywhere in the Edinburgh MBChB other than one introductory session for students when they join the programme in year 1 (and for ~20 students who join in year 3).

A VLE may also act as the voice of authority by acting as the medium through which official instructions, documentation, rules, practices and other decrees are represented to the user community. In this respect EEMeC has been identified as having an authoritative role:

"there is of course a slight authoritarian aspect that once there is consensus on things, like assessment, regulations and guidance, it is up there and can appear authoritarian. But it's only authoritarian if the community don't feel that they've had a democratic role in creating it" interviewee 3, appendix 10.3

The VLE may also affect the relative levels of empowerment of different participant groups. The following observation echoes some of the points made in the earlier section in this chapter on the participant groups in EEMeC's context of use:

"I think possibly the students might be more empowered because of the possibility to discuss things more with their colleagues in public. For staff it's difficult to say because they mostly don't use it. I don't know if it gives course organisers more authority as much as let them do a few things. It doesn't really affect their authority" staff interviewee 1, appendix 10.1

Related to authority and empowerment are the ways the VLE can influence the political dynamics of how the different parties express their control and power in the learning environment. In particular this relates to the political regime of the learning environment; whether it be democratic, autocratic or totalitarian. Most contemporary learning environments will blend autocratic and democratic principles and a VLE is unlikely to radically change this but it can certainly influence and change the status quo:

> *"I think it should encourage democracy because all of the information is there for everybody to see, we're not hiding things … so I don't think EEMeC is one or other. We use it in order to improve democracy but some may see it as authoritarian if they don't feel they contribute to that decision making that leads to that published statement" staff interviewee 3, appendix 10.3*

Although, if there is political change it may not be entirely welcome by all those involved:

> *"students are part of the system and have as much right as anybody else to discuss issues that concern them. To that extent I think it's got a beneficial democratic tendency and I could see that that might not appeal to some staff members that don't want students to have a voice" staff interviewee 1, appendix 10.1*

EEMeC can therefore be both a medium for the expression of authority in the MBChB and for its subversion. Although this creates a dialectical tension between the two forces it is the expression of appropriate authority and appropriate subversion that is seen, not totalitarianism or anarchy. In this respect EEMeC acts as a medium for the legitimate negotiation of power between the parties concerned without benefiting any party over much. In this respect EEMeC supports liberal but not libertarian principles of engagement in the MBChB community of practice.

10.5: Discussion

The analysis of the politics and forms of domination associated with the use of a VLE has provided useful insights, on the nature of the VLE, the way it is used and the learning environment as a whole. Indeed the politics of technology use, in any sphere, is intrinsically important, both to ascertain the effect that technology has and to ensure that it is not a negative one:

> *"if information technology is to be rescued for its most humane uses, one must at some point face the hard, unpleasant fact that the computer lends itself all too conveniently to the subversion of democratic values. This threatening liability arises precisely from what has always been advertised as technology's greatest power: the ability to concentrate and control information" (Roszak, 1994, p204)*

What in a learning environment constitutes subversion or a threat (and to whom), what the ideal political makeup of any given learning environment might be and whether democratic imperatives are appropriate, are also important but potentially problematic questions. Whatever answers are found or compromises made, it is extremely unlikely that the use of a VLE will be unrelated to the political climate of its context of use:

> *"though no particular set of values, political institutions, or cultural expressions necessarily accompanies technological change, history has shown time and again that those caught up in*

that change will always attempt to fix its cultural or political dimensions" (Hecht and Allen, 2001, p2)

EEMeC has been identified as facilitating both authoritarian and democratic change within the MBChB and there have been positive as well as negative consequences raised in the interviews and the analysis carried out in this chapter. A major factor determining the overall political impact of EEMeC is the absence of visible participation from teaching staff:

> *"[EEMeC] really only becomes really effective if we're all on board. At the moment only a small proportion of people are on board. It works very well but you have these great black holes. If you get the students thinking that everything is available on EEMeC and it isn't because two-thirds of the academic community are not contributing then it automatically limits the usefulness of the whole system. I think that down the line we have to get all the people who are contributing to it, particularly the administrators, to think electronically and not think in hard copy" staff interviewee 2, appendix 10.2*

The role of the VLE's developers and managers has been described and contextualised by taking a political perspective. As a result it is this group that has been found to be central to the way the system is built, implemented and run reflecting observations in chapter 5. However these individuals are often 'behind the camera' despite their key role in how systems are constructed and used. Reflexivity of this kind is not just important from a phenomenological standpoint; it is also crucial that developers are more aware of the impact of their actions upon learning environments as a whole. Those who control and wield technology can often be self-constructing in the way they interact with the world, and technology use independent of any particular artefact or system may becomes their sole concern (Hecht and Allen, 2001, p13).

There are professional concerns that developers need to be aware of their power and influence on the learning environment and their responsibilities so that they can act in the best interests of all those involved. This raises ethical questions such as 'should a VLE nurture and support a dysfunctional or destructive learning environment?' or 'when should a VLE's participants challenge or change the learning environment?'. Simply aligning their work to that of the context or use or to their own professional and personal objectives stands in peril of normalising bad practice and creating orthodoxies of dysfunctionality. What are needed therefore are general principles and ethics for the design, implementation and use of VLEs, both as a benchmark for evaluation and as a guide for all those involved in working with VLEs. The importance of such frameworks is increasingly important in all areas of systems engineering (Nissenbaum, 1997, p58).

The methods selected for this chapter are however not the only ones that can relate to power and domination. Attention could have been directed at ascertaining whether the VLE tends to support or decrease empowerment along lines of gender, race, religion or socio-economic background. Another early development in exploring political and organisational issues for this thesis was the development of the 'organisational cube' (Ellaway, Mogey et al., 2001; Ellaway, Mogey et al., 2002). This was one of a number of attempts to create typologies and frameworks to understand organisational makeup and the way it influences and informs the learning technology process (Dutton and Loader, 2002; Cornford and Pollock, 2003).

Taking an ethnographical approach to analysing power dynamics is open to bias emanating from the problems and advantages of being within and part of the context of analysis. The author was able to use her insider knowledge and experience of EEMeC and the MBChB to provide much interpretation and analysis but that should be seen in the light of her participation and political identity with the evaluation context. The use of interviews and other third party data provide substantiation and a more objective evidence base but the intrinsically ideographic nature of such a political analysis, particularly that of a single localised scenario, should itself be evaluated for reliability and generalisability.

Chapter 11: Evaluating EEMeC

11.1: Evaluating EEMeC

The preceding seven chapters have sought to evaluate EEMeC from each of Morgan's metaphorical perspectives on organisations. This has created a multiple methods evaluation structure, where each perspective has used different quantitative and qualitative techniques to create a body of evaluation data and interpretations about the VLE and the way it is used. This can collectively be seen as what Draper has identified as 'illuminative evaluation' designed *"to uncover the important factors latent in a particular situation of use"* (Draper, 1996).

A number of the evaluations overlapped conceptually (cultures and politics), methodologically (organisms and flux) or in terms of their findings (brains and cultures). While some of these overlaps were coincident (organisms and politics), others were complimentary (brains and flux). Overall this study has followed a 'theoretical lens' approach and in doing so has mixed concurrent and sequential patterns of inquiry and analysis (Cresswell, 2003). The sequence and coincidence of the different evaluations is shown in figure 11.1.

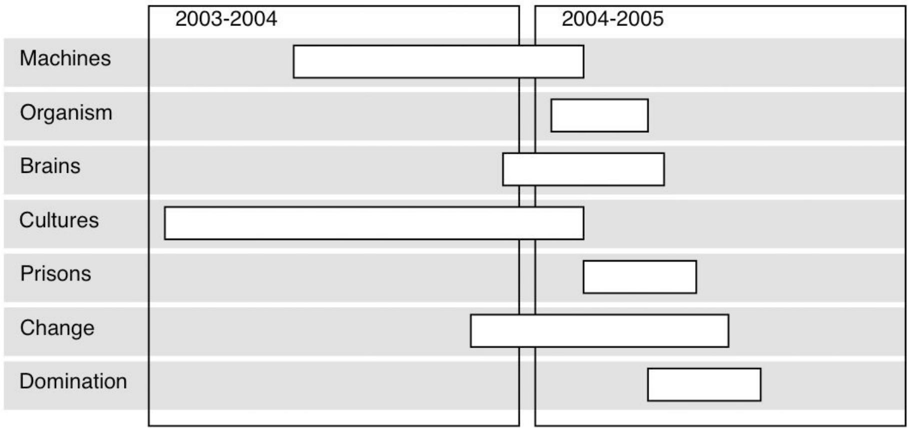

Figure 11.1: relative patterns of sequencing of the seven metaphor-informed evaluations of EEMeC through the academic sessions 2003-2004 and 2004-2005. Although data collection and methodology design was ongoing throughout the period preceding the performance of each analysis (and some reworking was carried out afterwards), there was a distinct sequence of analyses that fell into two periods; the two quantitative studies 'cultures' and 'machines' were carried out first, the remaining five largely qualitative studies formed a second block of cascading and overlapping analyses.

It can be seen that the two largely quantitative studies were carried out as a first stage (cultures and machines) with the remaining five largely qualitative studies carried out in a second stage. In this respect the study follows the quantitative-qualitative method of identifying attributes and themes, first using quantitative techniques to identify themes and factors and subsequently using qualitative techniques to elaborate on them (Tashakkori and Teddlie, 1998, p127). Although the framework of seven metaphor domains had been identified before data collection began, it was by using established techniques such as checklist evaluation and log analysis (machines) that more focused questions could be subsequently developed within other domains. It was the appropriation of Wenger's Learning Architecture Framework (Wenger, 1998) (cultures) that enabled a degree of elaboration on both the machine-derived questions, as well as factors and themes from the literature as a whole.

11.2: Evaluation Components

As a means to collate the evidence, the following section reviews the seven analyses, both in terms of the findings and the efficacy of the approaches taken. A review for each of the seven perspectives of the factors investigated and the subsequent methodologies adopted is shown in table 11.1.

	Main Factors	*Methodology used*
Machines	Intrinsic system properties, syntactic records of use	Software diagrams and metrics, log analyses and checklists
Organisms	Contextual factors and alignment with them	Development of a grounded model of key VLE factors in a learning environment, organisational metrics
Brains	Cybernetic and holographic factors: control and communication – what can and does take place	Generalised and user-validated use case scenarios, edge use case scenarios
Cultures	Cultural factors in a VLE context and support for a community of practice	Cultural review of the learning environment, user survey and analysis using Wenger's Learning Architecture Framework
Prisons	Affordances: usability, accessibility, constraint, interoperability and agency	Nielsen's usability heuristics, Bobby and W3C accessibility tests, review of unintended constraints, review of interoperability and user agency
Flux and Change	Forms of change and the effects of change	Impact framework (AIDA) and adoption factors framework (after Rogers)
Politics and Domination	Changes in power dynamics and their support within the VLE	Review of factions involved in the learning environment, review of the ways EEMeC acts as a medium of power

Table 11.1: summary of factors investigated, methodologies employed for each of the metaphor-informed perspectives on VLEs and EEMeC in particular.

11.2.1: VLEs as Machines

As VLEs literally comprise of computers and program code they are, in one sense at least, machines. This is therefore a literal metaphor. In the metaphor pre-analysis, described in chapter 3, 'EEMeC as machine' scored the third highest, indicating that it was resonant with members of the MBChB community.

The machine metaphor inspired a number of modes of evaluation, a recurring aspect of which was their syntactic basis, that is, they investigate the shape of things but not their meaning. System architecture models map out the topology of a VLE's internal structure but not what the components do. Software metrics measure aspects of the VLE's code in an application but not what it does. Log file analyses record a VLE's users' actions in the system but not why the actions are taking place. Checklists allow for predictive matching of features and functions to pre-selected or user-defined criteria lists. Despite this absence of meaning or purpose machine-based analyses are highly empirical and objective. They are based on quantitative data and literal interpretation and in this respect have a high degree of reliability and repeatability.

Of all the mechanistic techniques, the analysis of logfiles has been the most revealing. It has been able to provide a wealth of data on when EEMeC is used, by whom and how often, and as such it has provided an objective view of what actually does happen rather than what might happen. The log analyses have clearly shown a continually increasing level of activity in EEMeC over the years, marked by periodic variations associated with terms and academic years. They have also shown that members of the MBChB community are accessing EEMeC every day of the week and every hour of the day, a clear extension of contact for both students and staff. The log analyses have also shown that generally students have tended to take up this opportunity for extended engagement while staff have not. This may reflect a student's working life being focused on participating in the MBChB while staff rarely share this singularity of purpose, as they take on many different roles and tasks. Prior to using VLEs this kind of data was difficult to acquire.

A machine-based approach to evaluating EEMeC has been able to provide objective and quantitative data about this VLE-in-use, but without other dimensions of analysis it is limited in what it can say about a particular system. Despite this those who manage VLE services at an institutional level predominantly use machine-based information. An example of this is the UCISA report "Management and implementation of virtual learning environments" (Jenkins, Browne et al., 2001). This report is predominantly aimed at the IT and information management communities in UK tertiary education and is intended as a briefing to senior managers across the sector. The use of VLEs is measured in terms of whether systems are in place, what they are, and whether staff and students are able to use them. Their contextual measures focus on institutional decision processes for selecting VLEs, their technical aspects and the support and training that needs to be provided. This approach is limited to treating VLEs as ‘black boxes’; closed and neutral entities, and more importantly it treats the users of the system in a similar way. VLE neutrality is not however a realistic assumption to make:

> *“it is … impossible for VLEs to be pedagogically neutral. Every decision concerning presentation, navigation and design that is imposed by the VLE will impact on mediated learning” (Harris, 2001)*

Despite the utility of a mechanistic perspective, a VLE-in-use is more than (literally) the sum of its parts. Simply using checklists, system diagrams, and the ‘processing’ of students and staff is perilously one-dimensional unless it is tempered with more socially grounded approaches.

11.2.2: VLEs as Organisms

The idea of EEMeC as an organism is a non-literal metaphor; a VLE is not literally alive. Despite this, organism-related metaphors scored the highest positive response of all the metaphors reviewed and as such would seem to be particularly resonant with EEMeC users. Interestingly several biologists among the staff that took part in the study registered particularly negative reactions to this metaphor on the basis of a literal interpretation rather than as a way of approaching an evaluation.

The application of the organismic metaphor led to evaluations concentrating on the ways VLEs relate to their environments, in particular their fitness to their contexts of use. EEMeC was evaluated against a pragmatically derived framework of environmental factors; in other words one (virtual) environment evaluated as subsystem of another broader (contextual) environment. The broader environment was identified as having different kinds of distances associated with aspects of influence, participation and significance. These distances were identified as proximal or distal to the VLE. These concepts of distance were also used in subsequent analyses and evaluations.

The environmental analysis of EEMeC had a number of qualities, the most important of which was that it demonstrated the interdependence of EEMeC with its context of development and use. By doing so it validated the proposed differences between a VLE-in-abstract and a VLE-in-use. Other themes included the complex nature of the MBChB and the way EEMeC interacts with it, the political nature of the MBChB as a whole, and EEMeC in particular; the marked difference between technical functionality and utility, the marked difference between centralisation and devolution of activity, and the central role of the EEMeC developers. While this formative and essentially ideographic analysis was able to yield and structure a rich body of evaluation data, a second more quantitative approach was able to demonstrate some of the MBChB’s syntactic differences from the majority of programmes of study in Edinburgh.

The limitations of the organismic metaphor in structuring an evaluation include the fact that a VLE does not function as a single irreducible entity and that its design and use is informed by the choices and actions of those who use it and those who shape the environment in which it is being used. In this respect an organismic perspective is not just dialectically related to a machine model but also, by common factors, to culture and politics.

An organismic approach taken as a contextual analysis also implies a single pass evaluation. It neither covers the way the VLE works nor how it changes or reacts to change around it (although these factors are not alien to an organismic perspective). Functional aspects were subsequently covered in 'brains' and longitudinal factors in 'flux and change'. The important dialectic is with machines however, in as much that context-specificity and dependency are contrary to the repeatability and neutrality of a machine/objectivist approach. This raises an important issue for evaluation; a machine-like view of reality is implicitly compromised by the complexities of context and embodiment, a problem considered (but not resolved) in the work of Martin Heidegger (Heidegger, 1978). By explicitly relating the machine to its context it is the context that assigns value and meaning to the machine, there is no *a priori* meaning that need be accommodated:

> *"it is impossible to describe technology as value-free. Every technology takes on the values of the culture and climate from which it emerges" (Pool, 2003, p101)*

EEMeC has been shown to have very close relationships with its context of use, although it is not a perfect fit. Furthermore, an organismic metaphor has been shown to have value both internally as a means of describing the nature of the relationships between EEMeC and the MBChB (and the world beyond) and externally as a means by which the limitations of a machine-informed approach can be resolved and given meaning.

11.2.3: VLEs as Brains

The metaphor of a VLE as a brain is a non-literal metaphor; it was rated equivocally by staff and as such has neither positive nor negative overall resonance with EEMeC users. In terms of evaluating a VLE the evaluations followed Morgan's use of the brain metaphor to consider cybernetic and holographic aspects of the system. Cybernetics is principally about communication, feedback and controls within systems. Holographic principles on the other hand are focused on the internal self-organising properties of a system. Together these themes present a very large number of ways of considering VLEs. Indeed one of the more often cited approaches to evaluating VLEs has also used cybernetic principles based on concepts of viability (Britain and Liber, 2004a).

A simple starting point of cybernetic analysis was taken: Umpleby's basic themes of 'what can it do?' and 'what does it do?'. To answer these questions in a structured way, a number of use case scenarios were developed to cover the majority of user experiences and interactions with EEMeC. These were subsequently augmented by a small number of 'edge cases' that represented less common but still essential aspects of how EEMeC is used. Individuals with first hand practical experience of the scenarios subsequently validated them. The use case scenarios proved to be a very useful way to capture what EEMeC can do and the similarity to actual experiences of the users indicated that it was also a successful way of capturing what EEMeC actually does do. In that respect, the use case scenarios were an appropriate instrument to use for investigating cybernetic properties of a VLE.

What the use case scenarios demonstrated were the very wide range of different activities that EEMeC supports and the specificity of those activities to certain types of user. Teachers, students, administrators and other users had a number of activities that were particular to their role in the MBChB. This differentiation in user experience and therefore value and perspective is an important one; not only do different users do different things, EEMeC is different for different users.

These use case scenarios were not able to illustrate the technical functionality of the system, for instance the way EEMeC's security and authorisation works. This is because security is largely hidden from the user; it either works or it does not. The use case scenarios were also light on their ability to reflect explicit and implicit rules that govern the use of EEMeC. A significant limitation of use case scenarios in supporting holographic interpretation was the absence of longitudinal data of how EEMeC use changed over time and how human and machine control might be expressed as power and dominance. These were however addressed in subsequent chapters under different metaphor-informed analyses.

The use of a 'brain' metaphor was successful in that it led to the development of a number of scenarios that captured the way the system was used and that were verifiable by the users they represented. By linking aspects of cybernetic theory with grounded case studies many of the ways that communication, feedback and controls take place in and around EEMeC could be recorded. There were problems however, as was clearly indicated by the absence of longitudinal data in support of holographic analyses.

11.2.4: VLEs as Cultures

The metaphor of a VLE as a culture is a non-literal metaphor; a VLE may support a culture and it has already been shown that it is shaped and informed by cultural forces but it is not a culture in its own right. This metaphor was rated as a high positive by staff and as such has significant resonance with EEMeC users. The use of this metaphor led to the development of two approaches to evaluation; analysing the cultural context and influences on EEMeC and analysing EEMeC's ability to support its dominant user culture, the community of practice of the Edinburgh MBChB.

The cultural analysis concentrated on the proximal and distal cultures that use EEMeC or have some influence on it. Thus, although this was not strictly an evaluation of EEMeC it extended the contextual analysis from that developed under the organism metaphor to include wider considerations of some of the social forces that act within and upon the VLE.

The cultural dimensions of a VLE are hard to define, as much as anything because they are difficult to see and experience. As a response to this uncertainty the pragmatic approaches taken with the first three metaphors were replaced with a theory-driven approach. The analysis of the support for the MBChB community employed Wenger's Learning Architecture Framework (LAF), part of his work on theories of communities of practice (Wenger, 1998).

The responses to individual questions can be correlated with the other evaluations undertaken in this thesis. For instance the question regarding EEMeC's support of timetabling and scheduling (see appendix 7.2, figure A7.2.11) reflects the withdrawal of the timetables for years 3 to 5 recorded in the 'fit to context' analysis in chapter 5 and the longitudinal 'flux and change' analyses in chapter 9.

This evaluation indicated that EEMeC supports the MBChB well, although not evenly. There are marked differences in terms of the different dimensions of support it offers to different parts of its user community. This was mirrored in an evaluation of the medical VLE at the University of Newcastle, a system that shares many of the same drivers and environmental factors as EEMeC. Although generalisations are inadvisable without further trialling of the instrument on other VLEs (in both similar and different circumstances), a number of themes have emerged from the evaluation.

Both VLEs had 'convergence' as their highest rated item, which relates to community leadership, focus, vision and values. It would seem therefore that the way these systems act as a symbol and focus for their respective communities of practice is their most important aspect. The different ratings for the intermediate factors are indicators of the different dynamics of the two learning communities and the VLEs that serve them. While EEMeC is rated high for 'continuity' and 'competence' (issues such as initiative, tools and memory), the Newcastle system is rated high for 'reflection' and 'orientation' (issues of location and representations). The lowest scoring factors were the same for both systems; 'coordination', 'jurisdiction' and 'exploration', which relate to communication, feedback, authority, and scenarios and simulations. From this perspective the existence and presence of the systems seems to have been rated higher than the services they offer.

The other theme to emerge from this approach was the difference between the perceived effectiveness, utility and importance of different aspects of the system. Since effectiveness and utility were rated fairly evenly this would indicate that expectations are neither higher nor lower than the experienced utility of the system, while the consistently lower ratings for importance reflect the fact that EEMeC is not the principle medium through which the MBChB is transacted. This was in comparison to a subsequent interview (appendix 10.3), which rated importance higher than utility, and in turn higher than effectiveness. It was also illuminating that while staff rated 'exploration' third highest students rated it lowest of all. This demonstrates a significant discontinuity between staff perceptions of the strengths of EEMeC and that of the students.

Although the ability of the instrument to discriminate between Learning Architecture Framework factors has not been proven in any absolute sense this evaluation has proved illuminative in a number of ways. In particular it has indicated different dimensions of perception and value attributed to the VLE by individuals and the way these perceptions and values change depending on the cohort or group concerned.

11.2.5: VLEs as Psychic Prisons

The metaphor of EEMeC as a prison is a literal metaphor (all technologies constrain as well as enable their users). As a metaphor for EEMeC staff rated it as a medium positive. This metaphorical position considered EEMeC from the perspective of its affordances described as constraints. The concept of affordances, adapted from the work of Gibson (Gibson, 1979), were split into four themes; direct and indirect affordances and affordances of interaction and agency.

Direct affordances considered EEMeC's usability and accessibility using a number of existing and commonly used metrics. In this respect this part of this metaphor's evaluation was similar to the software metrics analyses undertaken in the machine metaphor evaluation. Although these found EEMeC to have no major problems it did identify some minor problems. These issues and the approaches are highly formative as EEMeC can and will be changed in the light of these analyses to improve both its usability and conformance with accessibility recommendations.

The consideration of EEMeC's indirect affordances used a number of essentially dialectical models to consider ways in which this VLE could act as a psychic prison for its users. These included themes of hidden curricula, equity, and heterogeneity. In comparison with the methods employed for the direct affordances, the indirect affordances were evaluated in an ideographic and discursive manner. Many of the issues discussed would need much more work to derive substantive conclusions from them and as such these are some of the areas that should receive further attention in subsequent research activity.

Interaction affordances concentrated on issues of interoperability, identifying it as a mutual condition between two or more systems with both technical and cultural dimensions. For EEMeC it is the latter that have been the limiting factor and as such reflect the relevance of the context evaluation undertaken under the organism metaphor and that of the political and domination metaphor.

Affordances of agency considered how much control and effect groups and individuals had on EEMeC. Users had greatest agency by right of their membership of particular groups but less as individuals. This reflects the organisational and institutional focus of EEMeC; it supports users as members of and participants in the Edinburgh MBChB programme rather than as discrete individuals.

There was significant mutuality between using the 'psychic prison' metaphor as a means to structure evaluation of EEMeC and the other metaphor-inspired evaluations. For instance control is a key issue within cybernetics and as such the 'psychic prisons' metaphor offers a negative counterpoint to the positive considerations undertaken within the evaluations inspired by the 'brain' metaphor.

11.2.6: VLEs as Flux and Change

This is a literal metaphor; VLEs do change and they do effect change around them. Despite this, staff scored it as a medium negative (the lowest scored metaphor) and as such it was not the way they saw EEMeC. 'Flux and change' allows a longitudinal perspective to be taken of EEMeC; how it has itself changed and how it has effected change around it. Operationally this involved the use of historical accounts and a timeline of key events. The collected evidence was then evaluated within two frameworks; one developed by the author around the multidimensional impacts that an innovation has on its environment and one based on Rogers' criteria for the diffusion of innovations (Rogers, 1995).

Although expected, these evaluations clearly indicated the extent to which EEMeC, and its environment, have changed over time. The fact that the evaluations are being carried out now rather than a few years ago or in a few years time does make a difference, as the system under consideration now is not the same as it has been in the past or will be in the future. The mutability of a system such as EEMeC emphasises its intermediacy; it was developed over time, it will be used and it will change as it is used, and it will eventually either be discarded or change beyond recognition.

The evaluations identified both negative and positive impacts, and the effects of change and the consequences of both. Decisions or policies in one part of the environment were seen to have impacts on other parts not foreseen by their instigators. For instance, the use of discussion boards, although considered by many to be educationally beneficial, has caused course managers concern over the way their use may subvert established channels of feedback and quality assurance in the programme.

The last main factor to come out of this analysis was the way that change is rarely if ever made *de novo*; there are almost always precedents and prior conditions that inform and are reflected in the way the innovation is executed and its consequences. EEMeC is as a whole a case in point in that it was deliberately built to be aligned with the Edinburgh MBChB. This displays aspects of holographic design (discussed in the 'brain' metaphor analyses). For a technology to be successful it must fit well to its context of use and as such must reflect many of the values and dynamics of that context.

Overall the flux and change metaphor has identified the multifactorial nature of change and the change that a VLE causes. In this respect it is orthogonally related to the other evaluations that have concentrated on evaluating the present state and essence of the system. The essence of change associated with a complex technology such as a VLE should inform the evaluation process and contextualise it within a longitudinal research perspective.

11.2.7: VLEs as Instruments of Politics and Domination

This is a literal metaphor in as much as a VLE might reasonably be expected to act as a form of control and reflect the power dynamics within its context of use. Staff score this as a small negative, which indicates that this is not the way the way that EEMeC is seen by them. In terms of evaluating EEMeC there were two positions taken. The first was to analyse the political factions involved with using EEMeC, and how its presence has changed their power and influence within the MBChB and beyond. The second was to evaluate the ways that EEMeC functions as a medium for domination and politics.

The factional analysis indicated that students seemed to have experienced the biggest change, being empowered in some areas (such as discussion and access) and disempowered in others (tracking and misinformation). Other than for a relatively small group of 'early adopter' teachers who have made great use of EEMeC and helped to develop it, most teachers seem to have been relatively untouched by EEMeC as they have little interaction with the system and therefore they neither control it nor does it control them. Academic managers have gained power as a result of the introduction of EEMeC whilst administrative managers appear to have lost power. Clerical staff have not gained power but they have had their jobs changed by the introduction of EEMeC, as information handling has become increasingly centralised. The most successful group has been that of the learning technologists. Their roles have moved from one of technical specialism on the periphery of the MBChB to holding significant amounts of responsibility at the centre of the programme. This reflects a change from a focus on creativity and design when building the system to one of processing and management now that the system is available as an ongoing service.

EEMeC was next reviewed as a medium of domination by the way it supports surveillance, conformity and authority within the MBChB. While EEMeC has the potential to record every user interaction, the amount of data actually captured is only as much as is required for the system to work and to meet the University's computing regulations. Furthermore the vast majority of the tracking data held remains unused, its main purpose (other than supporting system functionality), being the creation of an audit trail. Because the tracking data are stored within the VLE's database, the EEMeC team effectively controls access to it. Although the centralising nature of EEMeC and its control by staff (rather than students) has had a conforming influence, the free use of the discussion boards has also supported nonconformity. The main political culture associated with the use of EEMeC is one of constrained liberalism however with all parties engaged in a tacit 'social contract' as to what is appropriate. This last point counters critics of technology whose rhetoric commonly expresses ideas of technology as intrinsically invasive and authoritarian. In this way EEMeC is typical of many such computing technologies that are developed and used in a mindset of liberal and humanist aspirations (Coyne, 1995). It certainly was not an express requirement that EEMeC represent and advance the political interests of those it serves.

Overall, EEMeC has had a variety of effects on the political dynamics of the MBChB. It has supported and emphasised the authority of those who run and manage the programme whilst at the same time empowering the students by providing democratising affordances in the form of the discussion boards. The introduction of the new MBChB programme in 1998 marked a major shift of power and responsibility for undergraduate teaching from academic departments to a centralised course management team. EEMeC has subsequently enabled this group to be more vocal and visible as a result of EEMeC and the students are more politically vocal and active, and more visibly self-organising and self-supporting. Both of these parties' needs are more organised and visible yet teachers as a whole have apparently gained little power from EEMeC's introduction; their gains have mostly been in areas of convenience and opportunity to extend their teaching practices. Interestingly an awareness of the changes in the political makeup and dynamics and of the MBChB has largely gone unnoticed both by students and staff, reflecting the evolutionary nature of the changes and the normative ways they have been perceived.

11.3: Synthesis

Having assembled seven component evaluations based on different metaphor-informed perspectives on EEMeC, the next methodological question focuses on how they can be combined into a single evaluation. Aggregation and synthesis of component studies is a key issue for multiple methods techniques and as such can be approached in a number of different ways. These include triangulation (the cross-referenced combination of a number of sub-studies)(Denzin, 1978), cascade studies (an aggregation of practitioner perspectives and other components) and holistic and emergent approaches based on concepts such as grounded theory (Strauss and Corbin, 1998b). For the purposes of aggregating the seven component evaluations of EEMeC there were two approaches considered; triangulation and grounded theory.

11.3.1: Triangulation

Originating in the development of qualitative methods in the 1950s, the principle of triangulation is widespread, particularly in the social sciences, as a technique for approaching complex and ill-defined problem spaces. Denzin for instance has defined triangulation as having four types: *data triangulation* uses a range of different data, *investigator triangulation* combines information from multiple investigators, *theory triangulation* tests multiple hypotheses and *methodological triangulation* combines different approaches such as a mix of quantitative and qualitative methods (Denzin, 1978). The work described in this thesis equates to methodological triangulation. Seale describes triangulation as consisting of:

> *"systematic attempts to test out researchers' assumptions and arguments, so that these become both more convincing and at the same time more inclusive of a variety of perspectives" (Seale, 1999, p53)*

Triangulation has been recommended in circumstances that include complex phenomena, controversy, where existing methods are distorted or misleading or where the focus is a particular case-study (Cohen, Manion et al., 2000, p115). There are however problems associated with triangulation when it is used as a way of validating multiple method findings (Bloor, 1997). Massey has identified seven common errors in methodological triangulation (Massey, 1999): using one method to prove the truth of another; claiming matching data between two methods confirms both methods; taking similar looking answers to be the same; assuming researchers will code the same way as respondents; assuming data from different methods can converge or agree; believing the strengths of one method compensate for the weaknesses of another; and comparing two non-equivalent samples as if they were equivalent. These problems are caused by triangulated methods being too tightly coupled, often by taking the metaphorical concept of cartographic triangulation too literally. By creating a loosely coupled interpretation based on a combination of the various themes and threads a representative evaluation of the problem space should be obtained without falling into Massey's methodological traps:

- The logfile analyses demonstrated the difference between the patterns and quantity of use of EEMeC for students and staff. This correlates with the use case scenarios (brains), which describe quite different kinds of activities and experiences for students and staff, and the prisons and political analyses, which demonstrated quite different forms of constraints on and the power of these two groups.
- The development of EEMeC has followed the dynamics and culture of the Edinburgh MBChB is shown predominantly in the cultures analysis but also in the analyses for context (organism) and the use case scenarios (brain).
- The importance of adaptability and responsiveness to change is shown in the analyses for context (organism) and for flux and the ability for EEMeC to maintain continuity in the face of change is shown in the cultures analysis.
- A number of more detailed issues were echoed in different analyses. For instance concerns over the absence of timetabling for later years in the MBChB programme appear both in the context analysis (organism) and the Learning Architecture Framework triads (culture). The lack of teacher engagement with EEMeC is reflected in the studies based on context (organism), flux and politics. The central role of the EEMeC team is reflected in context (organism), the use case scenarios (brain) and the studies under 'flux' and 'politics'.
- The importance of access to computers outwith the University is shown in the use case scenarios and the equity discussion under 'flux', and is corroborated by the log files showing higher levels of access from outside the University than from within it.
- While interoperability is shown to be useful in the use case scenarios, the prisons and context (organism) analyses describe problems with trying to establish more interoperability between EEMeC and other systems. The nature of the problem is reflected in the tensions between distal and proximal actors identified in the political analyses.
- The heterodoxical approach of purpose-building a VLE in an institution that promotes a single off-the-shelf system is reflected in the context, prisons and politics analyses. The processes by which the decision to do this came about and the subsequent ways the development was undertaken are reflected in the flux and change analyses.

Some of the less useful aspects of the evaluation process are identifiable by their lack of corroboration by triangulation methods. For instance software metrics pertaining to system architecture or system code have no correlates other than those for cost (in context and flux). This is also true of the checklist evaluations of EEMeC (appendix 4.2) as they are concerned with the technical features of VLEs rather than how they are used or what effects this use has.

Triangulation can act as a means by which the data obtained by different methods can be correlated. However the issues raised by Massey limit the degree of meaningful coupling between data from different methods and therefore the analyses that can be performed using triangulation alone. There can also be no absolute validation of one method by another (Bloor, 1997). The triangulation process should therefore more realistically be seen as an addition and enrichment of the data rather than a confirmation of its absolute truth.

11.3.2: Grounded Theory

Triangulation is limited in what it can do beyond correlate and compare different analyses and data. An alternative approach is that of 'grounded theory', which:

> *"remains grounded in the conceptual structures of the subjects but yet produces a theory that can be used to understand and predict the reaction of these and similar subjects to future change" (Alsop and Tompsett, 2004)*

Grounded theory principles and techniques have already been used in this thesis in a number of ways:

- The research design was allowed to emerge from a range of perspectives based on Morgan's metaphors. Furthermore, there was no theory to test at the outset, rather theory and models were developed in an iterative response to data and the nature of the context of inquiry.
- Specific analysis frameworks such as 'fit to context' (organism) and 'AIDA' (flux) were built iteratively, based on feedback and testing and validation against the subject under study. Participant validation took place within the context analysis, for instance the use case scenarios and the fit to context analysis. The voices of participants are used within the learning architecture framework and interviews with members of staff are used in the politics and domination analysis.
- The research and analysis have been driven in part by the author's position as a practitioner and participant in the context under study. Aspects of research orientation and reflexivity are discussed in chapter 12.

There are different ways to employ the principles of grounded theory. Strauss and Corbin (Strauss and Corbin, 1998a) describe their methodology in detail, moving through three phases of coding; open (identifying categories), axial (combining categories) and selective (building and elaborating theories based around the development of a 'core category').

Although widely used, grounded theory is not without its critics. Concerns have been raised about its prescriptive and essentially positivist underlying themes (Seale, 1999). Nevertheless category and theory building approaches can be employed to explore the data and analyses collected under each of the seven metaphorical perspectives undertaken so far. A number of factors have already been identified as pertaining to the way EEMeC is used and the effects of this use on its context of use:

- EEMeC is heavily used though more by students than by staff
- EEMeC extends participation in the MBChB both in time and space
- EEMeC is a set of processes and practices more than it is a technological system
- EEMeC is intrinsically tied to its context of use
- Different kinds of EEMeC users experience and perceive the system differently and derive benefits (or otherwise) in different ways
- Both EEMeC and its context of use are intrinsically politicised
- EEMeC changes over time and is therefore not strictly the same system from one day to the next
- EEMeC supports the MBChB community of practice well although more successfully in some ways than others
- Although designed and used with positive and liberal intentions EEMeC has both constrained and limited its users as well as liberated and empowered them
- Neither the gains nor the losses associated with using EEMeC are in the area of student learning, thus, while it is called a learning environment, it covers many if not most domains of activity within the MBChB as a whole.
- EEMeC's outputs are not straightforward – learning cannot be causally made to happen, different individuals have different approaches to participating in any learning environment, and subjects and disciplines often have distinct approaches to teaching and learning.
- EEMeC is dynamic; internal and external pressures on education mean that courses and their contexts are constantly in flux, technologies change and the criteria by which value is attached to the VLE also changes.
- EEMeC's product is not endlessly repeatable; course outcomes are under constant review as internal and external pressures and the social context changes over time.
- Human involvement with EEMeC is not compliant and predictable; although there is a degree of compliance with course outcomes, it is probabilistic rather than absolute. Students and staff will all have their own agendas and will express differing degrees of compliance and predictably at different times.

The development of the axial coding model followed the typical grounded theory practice of first identifying elements and the relationships between them from the data, casting this into a diagrammatic theoretical model and then testing the model against the data for consistency and representativeness. Any inconsistencies, omissions or errors were identified, the diagrammatic theory model was updated and then it was reassessed. This process continued iteratively until the model reached a sufficient level of stability and representativeness. During the construction of the axial coding model for EEMeC it became apparent that at least two different models were required; a low level model that focused on its proximal characteristics in use (figure 11.2) and a high level model that focused on its more distal aspects (figure 11.3) as these two perspectives seemed equally valid yet modelled the phenomena in different ways.

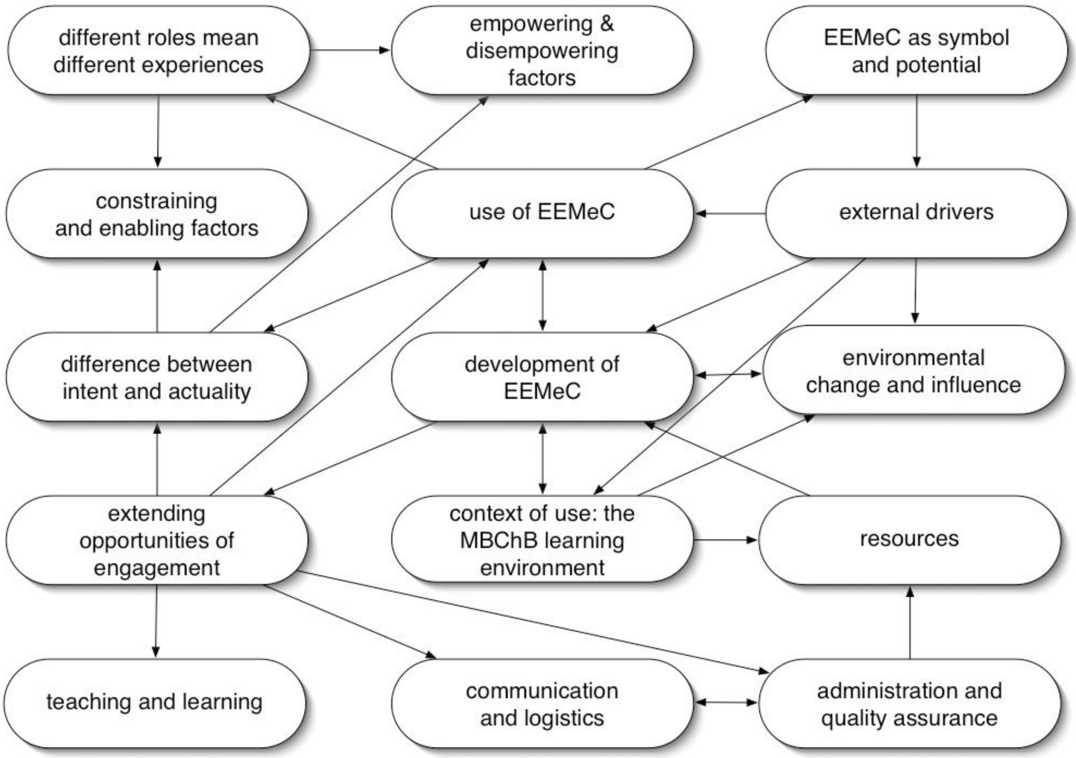

Figure 11.2: Low level selective coding analysis of the evaluation of EEMeC. The core categories emerging from this analysis are the 'use of EEMeC' and the 'development of EEMeC'. The importance of context is reflected in this core category but it is altered to reflect not the context as an abstraction but the context as a specific situated human and social construction. The development of EEMeC is the link to the general learning environment as EEMeC has been built to fit to it as closely as it can and as a result reflects much of its form and structure. External drivers (institutional, sectoral and discipline-based) drive change, as do aspects of the environment and the development of EEMeC itself. The development of EEMeC is mutually related to its use and it extends and augments opportunities (both quantitatively and qualitatively) to engage with the programme of study as a whole. The environment, the extension of engagement afforded by EEMeC, and EEMeC itself is about a lot more than teaching and learning. Administration and quality assurance factors are related to the resources available both for developing EEMeC and for the environment as a whole. Different kinds of user experience EEMeC in different ways and this affects the degrees and forms in which they are empowered or disempowered and constrained or enabled. There is also a difference between EEMeC's intended use and the way it is actually used (teachers use it less than might be hoped, students concentrate on discussion rather than using explicitly educationally-focused materials), which also affects the user experience. EEMeC's role as a symbol for the community, its potential for further development and as a way of addressing the requirements of external bodies also affects the use of EEMeC and the dynamics of power associated with it.

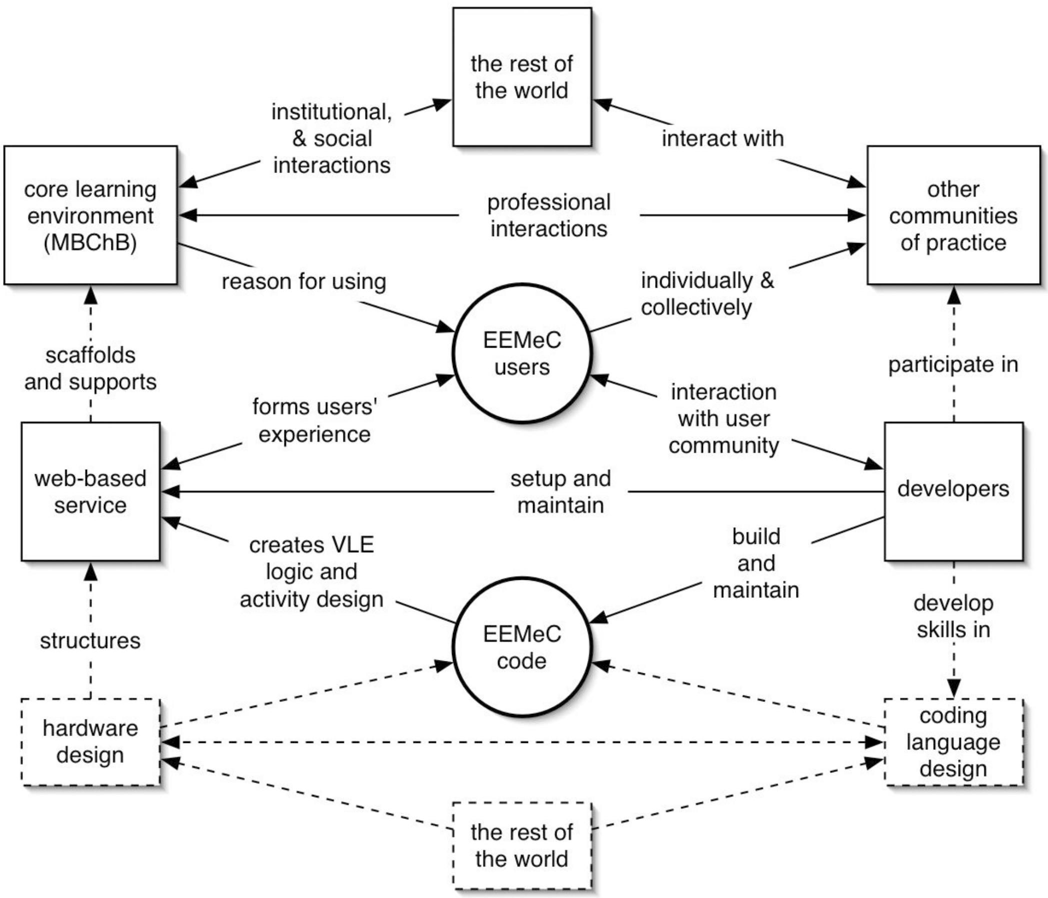

Figure 11.3: high-level axial coding model for EEMeC. The core categories are EEMeC code and EEMeC users, reflecting the difference between the VLE-in-abstract and the VLE-in-use. The secondary core categories are the developers and the nature of the service delivered by EEMeC, showing that the process of the system's creation and management and the outputs of that service are also very important. Note that both the technical machine-like aspects and the social aspects of the VLE relate back to the rest of the world. In this respect the model should be seen as cyclic with the top attached to the bottom identifying the machine-human dialectic within VLEs to be illusory.

Using aspects of a grounded theory methodology has enabled a greater level of cross-method analysis, coding and representation than for triangulation. This is perhaps not surprising, for while grounded theory comprises a comprehensively structured set of methods and procedures triangulation is a more abstract concept based mainly on a metaphor of multi method analysis as a form of cartography or surveying. Triangulation is a far less specified approach than grounded theory, the latter depending as it does simply on correlation and confirmation between findings from different methods.

11.3.3: Validity and Reliability

Questions have been asked, methods developed, data acquired and analysed and grounded theories developed. This chapter has sought to tie the seven different perspectives and their associated methods and data into a single view of EEMeC. Having now completed that step, how valid and reliable has this process been? There are many different perspectives on validating findings from qualitative or mixed methods research. Lincoln and Guba for instance list four essential validity criteria that cover both conventional and naturalistic inquiry: credibility, transferability, dependability and confirmability (Lincoln and Guba, 1985), while Miles and Huberman consider five criteria (Miles and Huberman, 1994, pp278-280). It is the latter framework and their associated queries that will be used as a basis for reflecting on the quality of the data and its analysis:

- *Objectivity/confirmability*: as far as possible all methods and procedures have been described clearly and in detail and conclusions linked to this data. Mixed methods were required because of the limitations of using just one research method or paradigm to explore a complex phenomenon such as a VLE-in-use. Experimental studies were problematic because control groups that would go without EEMeC were not available and there were so many change factors in the environment (new curriculum, institutional reorganisation, changes in external regulations, rapidly developing technologies etc) that isolating those for EEMeC were impractical. Purely qualitative studies were also problematic because of the essentially parochial scope of considering just one VLE in one programme of study. The sequence of deriving questions, methods, data and analyses is described within each metaphor chapter and within this one for the aggregate analysis. The role of personal orientation and bias on behalf of the researcher has been considered at several points along the way and will be reprised in the following chapter. Alternative methods were used within most of the metaphor analyses and compared for contradiction as well as agreement. All study data has been retained. Much of it is to be found in the appendices that accompany this thesis.
- *Reliability/dependability/auditability*: the research questions were relatively unformed at the outset, as part of the process was to find ways of asking better questions. However with the adoption of a multiple method approach and the use of metaphors to frame it, the questions could be developed more solidly and methods derived to answer them. The researcher's role has been identified clearly throughout, and there is a high degree of agreement between the findings from different methods. While some data spanned many years (log files, flux and change), others used data from single collection points (cultures). Coding checks were carried out on a number of analyses (organism, brain and flux) using participant validation. Peer review of the work was carried out by publishing of some of the techniques, analyses and findings used in this research (Ellaway, Cameron et al., 2002; Ellaway, Dewhurst et al., 2003a; Ellaway, Dewhurst et al., 2003b; Ellaway, Dewhurst et al., 2004; Dewhurst and Ellaway, 2005).
- *Internal validity/credibility/authenticity*: in that the concept of VLE-in-use was the starting point of this investigation the context richness is very high throughout this study. The triangulation analysis demonstrated general convergence and internal coherence of the different component studies and the grounded theory approach was able to create a degree of modelling and theory building on top of this. Relationship with theory was considered throughout, and while some approaches used theory as a referent for developing new approaches (organism, brains and flux)

others used existing theory to structure the enquiry directly (culture (learning architecture framework), prisons (usability and accessibility) and flux (Rogers)). A number of areas of uncertainty were identified including the quality of the mapping between general learning architecture framework factors and the instrument derived from them, and the views of students on particular metaphor analyses (prisons and politics – students were unwilling to participate in interviews regarding these matters). Participant validation was discussed in the previous criterion.

- *External validity/transferability/fittingness*: efforts were made to ensure the characteristics of the samples were adequately described. The threats to generalisability of this study have been considered and it is accepted that an in-depth study of a single setting will have limited direct and objective generalisability. Only two general theories have been elaborated in this thesis: the key empirical differences between a VLE-in-abstract and a VLE-in-use and the utility of using a coherent metaphor-based framework to structure a multiple methods evaluation of a complex and multifactorial subject. The grounded theory regarding EEMeC that was developed in this chapter has yet to be tested outside this immediate context. Nonetheless individual chapters have been passed to colleagues in other institutions and in other countries, either in response to direct requests or as part of collaborative work undertaken with respect to VLEs. Feedback has been very positive, with correspondents reporting consistency with their own experiences and utility in their own work. This has provided a degree of formative validation of the transferability of this work. A number of the component evaluations made suggestions for further testing and development and the overall methodology should be tested in other settings and with other VLEs. The one occasion this was done within this thesis was using a variant of the learning architecture framework evaluation for years 1 and 2 of the medical VLE at the University of Newcastle. Even this one parallel study was able to raise further questions and extend the utility of the framework.
- *Utilization/application/action orientation*: it is hoped that the findings in this thesis are intellectually and physically accessible to the learning technology and medical education practitioner and research communities; successful instances of pursuing dissemination and engagement with other practitioners in this work have already been discussed.
  Whether readers will develop the work further has yet to be seen.

One other concern has been the problem of getting user participation in all aspects of this research. This has been particularly problematic for students who have been particularly reluctant to spend time participating in this research, although more than one academic declined to participate in any research for which they would receive no academic credit. As a result some of the evaluations were particularly ideographic; a reflection of the pragmatic approach taken throughout that has been able to avoid problems of ‘methodological paralysis’ (Melia, 1997) by making best use of what opportunities there were rather than over stretching any individual approach. By judging the work presented in this thesis against the Miles and Huberman criteria, there seems to be reasonably high levels of validity and reliability throughout. This is not to play down the weaknesses inherent in a study undertaken by a practitioner of their own area of work but these will be considered in greater detail in chapter 12.

11.4: Discussion

The methodology adopted for this research has been to employ a range of metaphor-informed perspectives, and methods derived from them, to investigate the way that EEMeC is used and the effect it has on its context of use. This chapter has sought to bring the data and analyses created together into a single model or theory about EEMeC. Although this may extend to other similar VLEs and contexts of use, this was not tested in this body of research. Each of the individual metaphor-informed analyses addressed aspects of the dialectical tensions between the metaphor object and subject. There is however an inherent problem when trying to dialectically resolve more than one metaphorical construct at the same time. While the ways that a subject may (or may not) be like the object of comparison for one metaphor are informative, a plethora of commonalities and contradictions cannot be resolved simultaneously. For this thesis resolution was accomplished by using aspects of triangulation and grounded theory rather than dialectics.

Triangulation, while an oft-cited solution to many research problems (Tashakkori and Teddlie, 1998), is limited by what can be safely done with it (Massey, 1999). All constructs based on continua are dialectical in nature (Coyne, 1995) and are therefore intrinsically contradictory as well as illuminative. Many of the constructs used to model VLEs in chapter 2 are dialectical constructs, for instance 'off-the-shelf or do-it-yourself', 'generic or context-specific'. The synthesis of data and analyses acquired using a multiple methods approach was able to be more structured using grounded theory methods than using triangulation and led to the creation of a coding model linking the main factors identified in this research.

Issues of validity and reliability were considered using Miles and Huberman's criteria and the study was found to be both valid and reliable overall but limited in the extent to which it can be generalised. Although the techniques and methods developed will need further elaboration and testing to establish the extent to which they can be generalised to other contexts, material in this thesis has already been used by practitioners elsewhere. The next (and final) chapter will revisit study issues such as reflexivity and utilisation of this research, and will draw the thesis to a close.

Chapter 12: Conclusions

12.1: Evaluation, Reflexivity and Utilisation

The focus of the investigations under each of the seven metaphors has been one of evaluation rather than research as the intent has been less about the summative revealing of truths than it is about the formative improvement of services (Clarke, 1999). This reflects the author/researcher's position as both practitioner and participant in the environment under scrutiny and the anticipation that the work will have practical local benefits. There are therefore two further issues that need to be considered in framing the work; the orientation and role of the researcher and evaluation utilisation.

12.1.1: The Role of the Researcher

> *"it is a mistake to think that the assessment of technology can rest content with the idea of usefulness; it necessarily passes on to the idea of the valuable" (Graham, 1999, p50)*

But who decides what is valuable raises a fundamental question, if the evaluator is asking some questions and not others what effect does this have on the answers obtained? Although mention has been made of the role and orientation of the researcher with respect to this thesis at a number of points along the way,

> *"the theoretical position of the researcher is fundamental to their interpretation of data" (Conole, Oliver et al., 2004)*

As such, particularly in respect of qualitative investigations, the researcher cannot be considered as an impartial and disinterested party. They are implicated in the choice of research questions, the choice of methodology and structure of the study and in the interpretation and meaning attributed to its findings. This is an even more important factor when the researcher is a direct participant in the area under investigation; in this respect the inquiry follows patterns of ethnography (Hammersley and Atkinson, 1995) and action research (Patton, 1986).

There are a number of negative aspects of practitioner evaluation:

> *"practitioners, who may be experts in a range of areas, may not have any prior experience of carrying out an evaluative study … in addition, evaluation often forms a relatively low priority within projects, not least because it is an unfamiliar and poorly supported activity that can seem unrelated to the completion of other, more tangible, project aims" (Oliver, 2000)*

And there are positive aspects too:

> *"the greatest benefit is derived when practitioner-evaluators conduct evaluations in their own schools, 'because then they know the culture'" (Alkin, 1990, p76)*

The main concern regarding practitioner evaluation is in respect of bias and partiality. A number of methodological steps have been taken to minimise this including participant validation, formal and informal peer review of components of this thesis, and combining and correlating methods. In addition to the validity and reliability factors discussed in the previous chapter, this section will report on the more general aspects of the author's orientation and position with respect to the work undertaken. This will take the form of a personal statement and a review of supporting evidence.

12.1.1.1: Personal Statement

Although the rest of the thesis has been written in the third person this section is a personal statement about my role and orientation with respect to this research and as such will be given in the first person. I am the principal architect of EEMeC and have managed its development from the beginning. In this respect I have had a uniquely privileged perspective on the development and deployment of this purpose-built VLE, a vested interest in developing the system to its fullest potential and a professional interest in the development and use of VLEs in general.

EEMeC had been running for just over a year when I began this PhD so the development of both the research and its subject has largely progressed in parallel. Each has informed the other at a number of points and has benefited substantially from these interactions. However, the fact is that EEMeC is a live system providing services to real students and staff and I am responsible for the quality of service it provides, which has required a degree of disconnectedness between the provision of the system and my research in to it.

At the outset of the research there was little in the way of substantial experience or knowledge available regarding the way VLEs should be developed and used in medical education (Quentin-Baxter, Hammond et al., 1999). Nevertheless EEMeC began at the time when commercial systems like Blackboard and WebCT were beginning to make serious inroads in to the tertiary sector in the UK and the dominant philosophy was that local purpose-built systems were anachronistic and unsustainable. It was clear to us however that the generic systems available were ill fitted to the Edinburgh MBChB and that there was little choice but to create a system that did meet its needs.

Over time, and although the decision to go it alone has been challenged a number of times, the advantages have continued to outweigh the disadvantages, and as a result the research focus changed from 'what are medical VLEs like' to 'what is it that makes this approach successful'. As a result there are some grounds to accusations that this research was developed in part to defend against the arguments of those that would see EEMeC abandoned in favour of a generic system. However, substantial efforts have been made to keep the work impartial and objective and the research questions open to answers that would count against a contextualised development methodology as well as for it. The use of a multiple methods approach that attempted to create a holistic picture of a VLE-in-use was therefore a response to the problem of substantiating the perceived benefits of such an approach without excluding findings that militated against it.

At the outset the range of issues and interdependent factors that were involved with evaluating VLEs initially appeared to be overwhelming, in particular the many intersecting aspects of technology, psychology, sociology, pedagogy, organisational theory, history, and medicine. The complexity and plurality of the problem space fitted philosophies of 'naturalistic enquiry' better than those of 'positivist enquiry' and although:

> *"naturalistic inquiry can at best persuade" (Lincoln and Guba, 1985, p329)*

it was persuasion and dialogical investigation that were more important than absolute truths or general theories of VLEs. As evidence of this position regarding the use of aligned or generic VLEs, a dialogue between Tom Franklin (then at TechDis) and myself has been presented in appendix 12.1. This dialogue represents an exchange that took place in 2002, which informed aspects of the methodology and frameworks later used to structure this research.

The result of this research has been a grounded theory of the dynamics of the Edinburgh MBChB in the presence of EEMeC that indicates the extent of the interconnection between all parts of the learning environment, both online and face-to-face. Although this thesis comprises a final report on the research, EEMeC continues as does the research themes developed within it. One body of inquiry is reconsidering the 'distances of education' (after (Agre, 1999)) in terms of the orientation and participation of learning technology services (Ellaway, Begg et al., 2005). Another is developing theories and practices of 'constructively aligned' VLEs (after Biggs (Biggs, 1999)) (Ellaway, Dewhurst et al., 2004). A third is looking at the politics and organisation of blended learning in professional tertiary education (Dewhurst and Ellaway, 2005). I would not have undertaken such extensive research into EEMeC if it were not for this PhD however and as such it has acted as a catalyst on my developing professional activities both as a VLE practitioner and researcher.

Although I remain convinced that proximal engagement and alignment with specific learning environments is an appropriate approach to take when developing and deploying learning technologies, it is with far less confidence in any intrinsic goodness of situated learning environments and a much greater appreciation of the emergent and process-oriented nature of teaching and learning. I am also converted from a positivist and rational view of technologies being developed to serve identified needs to an appreciation of the social construction of technologies and the partiality with which participants and users approach them. It is perhaps best summed up as:

> *"the real benefits usually are not the ones that we expected and the real perils are not those we feared" (Tenner, 1996)*

12.1.2: Evaluation Utilisation

There are tensions between formative evaluation (while an activity is running: improvement focused) and summative evaluation (at the end of a process to assess its success and worth: outcome focused).

The work undertaken within this research is essentially formative as EEMeC is in no sense 'finished'. Evaluation is not carried out as an activity in its own right; it is intrinsically a means to an end:

> *"as a form of applied research, the primary purpose of an evaluation is to assess the impact of a social programme, with a view to providing information to help those people responsible for making decisions about the future of the programme" (Clarke, 1999, p173)*

The links between the development of EEMeC and the development of this research have already been discussed and the local utilisation of this work has as a result been shown to be quite extensive. In particular, the development of theories of VLEs-in-use have framed and substantiated the approach taken with EEMeC and provided a means by which dialogue with those who promote VLEs-in-abstract can be more productively pursued. These theories have also enabled a more critical approach to developing EEMeC and contextualising it within the larger learning environment.

Specific evaluations have provided local utility in a number of ways:

- *Machines:* the development of cost metrics has enabled more specific and meaningful dialogue over costs, both regarding existing activity and that associated with proposed developments. The in-depth development of log analyses have also been particularly useful in discussing issues such as patterns of study and provision of student computing facilities.
- *Organism:* reviewing EEMeC's fit to its context of use has identified areas of weakness in its provision and integration with the MBChB programme. In particular this has clearly identified the problems associated with the lack of senior administrator engagement with the EEMeC process. It is as a result of identifying this problem that extra effort is being put into building bridges and ways of working with MBChB administrators.
- *Brains:* the use case scenarios have proved useful in being able to represent the range of different user experiences to the EEMeC user community as a whole. Furthermore they have allowed the hypothecated expectations of the developers and managers of EEMeC to be compared with those of the users they represent. The end result of the use of use case scenarios has been a much greater understanding of different EEMeC user experiences and much greater transparency between them. Developing use case scenarios has now become a regular part of local system planning and evaluation.
- *Cultures:* the Learning Architecture Profile for EEMeC has prompted some serious reflection about the nature of EEMeC and its focus, part of which has been an acknowledgement of the lack of opportunities for exploratory learning that the system provides. The free-text comments and responses to the individual triad questions have also helped to focus attention on problem areas of EEMeC (such as the absence of timetables after year 2).
- *Prisons:* the evaluations of EEMeC's usability and accessibility were intrinsically formative and structured towards making corresponding changes to the system (which are being enacted). The review of indirect affordances/constraints has led to a greater sensitivity to and

awareness other constraints that the VLE introduces to the learning environment and the review of user agency is being fed in to quality assurance processes.

- *Flux:* although the participants in the Edinburgh MBChB have lived through EEMeC's history, a formal review has helped to identify what has and has not changed, it has provided a better view of the different factors involved in its development and it has provided an aid for orientation for more recent joiners, in particular EEMeC developers.
- *Politics:* the politics of the development and evaluation of EEMeC has possibly been the most contentious aspect of the evaluation. Although there are democratic and liberal intentions to empower everyone and disadvantage no one, this has, perhaps not surprisingly, not been possible. At the time of writing there is a debate whether students should be able to post criticisms about the MBChB so publicly. Some are worried about this painting a particularly negative picture about the state of the MBChB, while others support freedom of speech no matter what.

It is difficult to report on the extent of the use or impact of this research on work elsewhere as this will take time and is partly dependent on the work being completed. However, there have been four factors associated with whether evaluation is utilized and to what extent (Alkin, 1990, pp70-71) that can be used to reflect on utilisation of this research:

- Evaluator characteristics: their commitment, their engagement and rapport with potential users of the evaluation, and their political sensitivity and credibility. As a VLE practitioner and critic the author has already made a number of contributions to the community by disseminating findings from this research and will continue to do so in a number of media.
- User characteristics: their interest in the evaluation and their opportunities and scope for utilization. A growing number of practitioners have asked for and made use of components of this research. Other aspects of this work is being used within two reports currently being prepared on medical VLEs (Cook, 2005; McDonald, Quentin-Baxter et al., 2005).
- Contextual characteristics including organizational factors, politics, regulation, and the complexity of the potential context of use. Although medical schools vary significantly in their make up and dynamics, it is anticipated that in this context at least the work presented here will have both resonance and utility.
- Characteristics of the evaluation ('the way that it was done'). The evaluation (rather than general research) approach adopted should make it more accessible and usable by third parties. Issues relevant to this point were discussed in chapter 11.

Overall, the utilisation of this research is already quite high and it is expected to grow over time. The eventual assessment of its utility will however perhaps depend on whether the work begun here continues to develop over time into embedded practitioner and researcher methodologies for assessing VLEs-in-use.

12.2: Discussion: VLEs-in-use

The definition of and differences between VLE-in-abstract and VLE-in-use were originally set out (in chapter 2) as follows:

- *VLE-in-abstract:* systems considered, developed or deployed without regard to any specific learning context.
- *VLE-in-use:* systems considered, developed or deployed with regard to a specific learning context.

Although aspects of the former were considered in the 'machine' evaluations (checklist reviews for instance), it has been an example of the latter that has been the focus of this thesis. Because VLEs tend to be large and encompassing there are likely to be very few of them in any one locality. Indeed it is unusual for there to be more than one VLE in use in any given learning environment, although there are hybrids where one system has been grafted on to another; Dundee University has combined their locally built medical VLE with Blackboard and Birmingham University has done the same with their medical VLE and WebCT. The opportunity to compare two or more VLEs in one setting is therefore unlikely to occur and very likely to be both unwieldy and disruptive. Such a comparison is also rather pointless as it is the integration with all aspects of a course context that gives VLEs their strength and using more than one will by necessity limit the extent of their use.

Although the evaluation of VLEs across multiple contexts has been undertaken (Browne and Jenkins, 2003), detailed investigations using a systematic holistic methodology, such as that employed in this thesis, appear to not have received attention. This may reflect the large scale and normalising nature of VLE implementations across institutions and the resulting (although largely implicit) challenges to diversity in educational methods and philosophy. Despite this there is little doubt that contextual analysis is important (Crook, 1994, p9). The complexity of contextual factors and the ways they interact with and redefine technology use in education has emerged as an essential determinant of the forms and extent of adoption. This is magnified when technology use is actively about building a system within these influences rather than passively using a pre-designed system. The technology process is therefore also defined by contextual factors. The prevalence of a particular system or a technology is often less about a rational choice between different options and more about pre-existing trajectories of the participants (MacKenzie and Wajcman, 1999, p22).

The consideration of issues of complexity and coherence allows us to introduce other ways of looking at VLEs-in-use. In defining general systems theory Weinburg identifies three approaches to inquiry: organized-simplicity, which is open to simple scientific analysis; unorganized-complexity, which is open to statistical analysis; and a third intermediate region of organized complexity (Weinburg, 1975). Although a learning environment is complex it is also coherent and is therefore demonstrates system-like properties of organized complexity.

Checkland defines nine characteristics of systems (Checkland, 1981, pp173-174). An entity is a system if and only if; it has ongoing purpose, it has measures of performance, it contains decision-making processes, it contains subsystems, it contains connected and interacting components, it exists in a wider systems context, it has boundaries separating it from other entities, it has resources, and it has continuity. For VLEs-in-abstract, system-like characteristics are limited, at best, to their potential reflected in its tools. For a VLE-in-use the characteristics are represented both in the VLE and its educational context of use in an inseparable duality. Not only are the two kinds of VLE model quite different from each other, methods for investigating them and the kinds of knowledge about them that can be generated are also quite different.

Although the Weinburg model reflects approaches to inquiry, there are similar axial models for modelling other issues such as social complexity and organisation. It has been observed for instance that the only way to organise activity on a large scale is to reduce its social complexity (Strum and Latour, 1999). VLEs that encompass whole institutions must therefore of necessity reduce the social complexity of the educational settings they support. The alternative of organising technology processes within existing social systems can preserve more diversity than those organised outside them but at a cost of reduced scale of organisation. Because EEMeC has been aligned to the Edinburgh MBChB it is not aligned to any other educational setting except perhaps by chance or similarity. Two years after EEMeC began, a system was cloned from it to support the undergraduate veterinary students in Edinburgh, and three years after that it was cloned again to provide support for the postgraduates in the College of Medicine and Veterinary Medicine. In pursuing alignment with their respective contexts of use the three systems have diverged markedly from their starting points and are continuing to develop along different lines in response to different drivers. Given the opportunity, even systems that start from the same technical point will diverge and follow their own paths (Scarborough and Corbett, 1992, p10)

It is clear both from the body of research already presented and from more theoretical perspectives that alignment to context of use is a defining characteristic for VLEs. The model of 'VLE-in-use' is one that reflects the contextualised use of such systems and as the basis for the substance of this thesis it has been demonstrated to be of great utility and value in approaching the evaluation of VLEs.

12.3: Discussion: metaphor as method

If one of the cornerstones of this thesis was 'VLEs-in-use' then the other was the use of a metaphor framework for structuring a multiple methods holistic analysis of such a system. The use of metaphor for framing and structuring inquiry is well established (Lakoff and Johnson, 1980; Grant and Oswick, 1996; Morgan, 1997) and has been used before with respect to learning environments (Wilson, 1995; Schwier, 2002). The extent and depth of metaphorical framing in domains such as learning technology has major implications for inquiry as they are linked to ontological assumptions about the very nature and subject of research (Pulkkinen, 2003). From an experimental point of view Miles and Huberman have identified four uses for metaphor in qualitative inquiry (Miles and Huberman, 1994, pp251-252) where metaphors can act as: *data-reducing devices* by creating abstractions and generalities; *pattern-making devices* by associations with the metaphor object; *decentering devices* by requiring analytical or inferential thinking; and *links between findings and theory* by abstraction from specific cases.

Rather than letting the metaphors emerge from the data or its analysis, a pre-existing metaphor-based framework was adapted from its original use in organisational analysis (Morgan, 1997) to structure the evaluation of EEMeC. The resulting research and evaluation has been rich and incisive while retaining consistency and coherence. When Morgan's metaphors were introduced in chapter 3 they were mapped against a bimodal grid that placed them in a sequence from machines being technical and quantitative to politics being qualitative and social (see figure 3.1). Having now undertaken evaluations based on taking those metaphorical positions the bimodal continuum can be redrawn to represent what actually took place (see figure 12.1). Interestingly the metaphors covered a third continuum of criticality. While the early metaphors observed (machines, organisms, brains) the latter metaphors increasingly introduced critical themes (prisons, flux, politics). The dialectical continuum between the technical and the social was contradicted by the cyclic high-level axial coding model developed in chapter 11. A similar approach of mapping out the coverage of the seven component evaluations can also be taken using this alternative model (see figure 12.2).

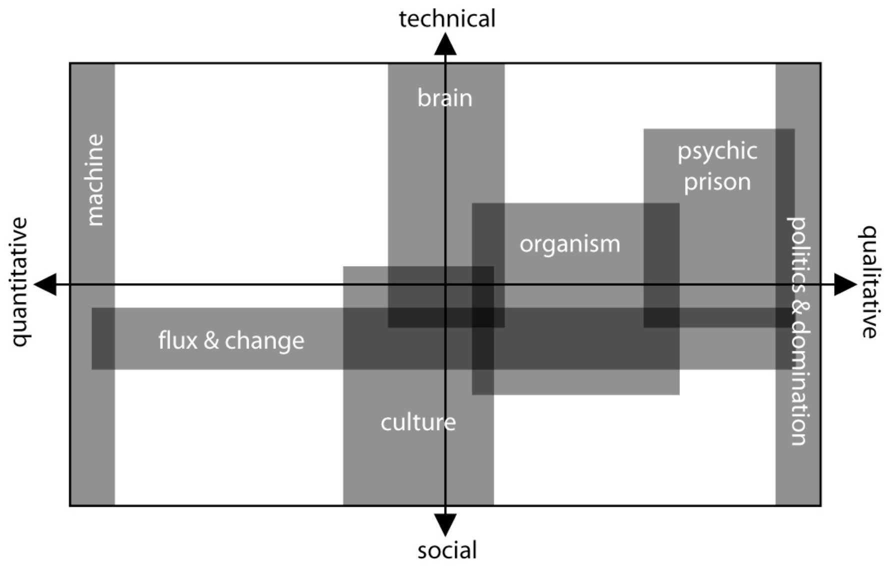

Figure 12.1: metaphor evaluation domain map for the evaluation of EEMeC using 'Morgan's metaphors'. The metaphor-informed evaluations have covered different areas of the bimodal domain space and have tended to overlap in places. Note that this diagram is intended to be purely illustrative; no scalar interpretation should be made. Using Morgan's metaphors as a framework for components of a multiple methods evaluation has therefore enabled the inquiry to span two significant continua with overlaps between different approaches providing some degree of correlation between them.

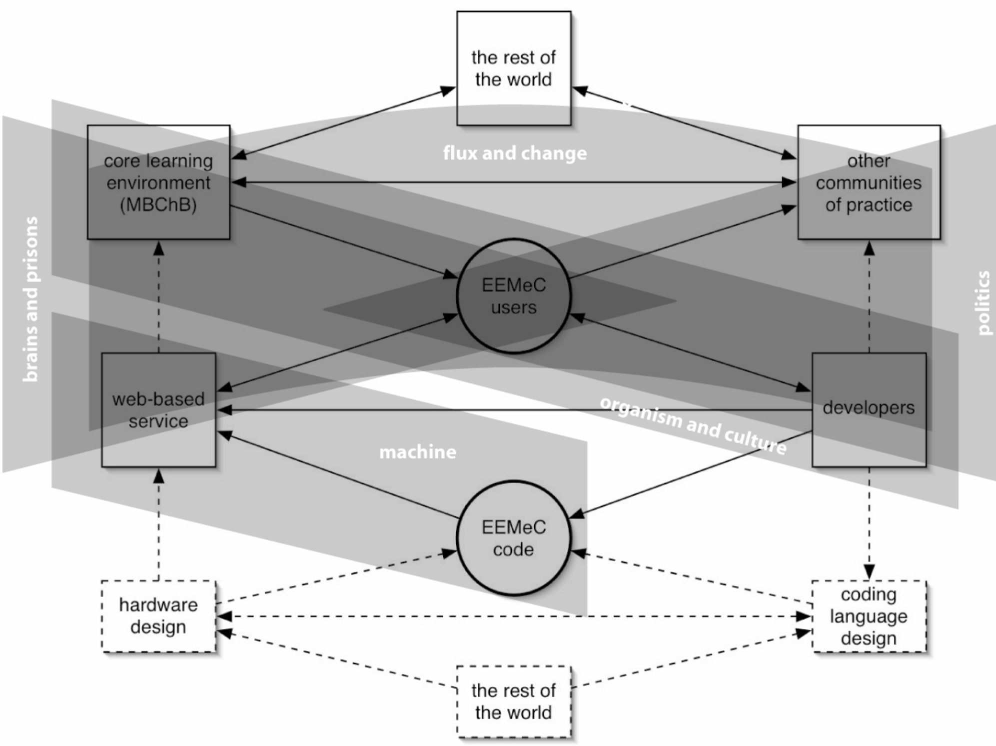

Figure 12.2: density diagram mapping areas of investigation to the high-level axial coding diagram from figure 11.3. The focus of this study is clearly identified as having been on EEMeC's use and users, followed by the nature of the service delivered, its development and its context of use.

Despite their utility, the decision to use Morgan's selection of metaphors is neither exhaustive nor definitive. Some alternative metaphors for EEMeC were identified earlier in the user acceptance review in chapter 3. We can project the highest three ranked metaphors as components of an alternative framework:

- *Conduit:* if a VLE is a conduit this begs the question 'from where to where', 'what passes through this conduit' and 'under what conditions'. Specifically, analyses could be conducted on users' transactions to ascertain what they were doing and how successful they were in doing it and could be based on correlating log files with user interviews or observation. This could reflect theories of VLEs supporting conversational models of learning (Britain and Liber, 2004a). Other questions could include why certain conduits have been built (and others not) and what kind of interactions or traffic they afford. In this respect the 'conduit' metaphor shares certain similarities with Morgan's 'brain' and 'machine' metaphors.
- *Container:* a VLE as a container raises questions of 'what it contains', 'for what purpose' and 'for whom is it stored'. Analyses could look at the different types of material stored (logistical information, course information, teaching and learning materials), how often they are used, by what kinds of user and in what context. A 'container' metaphor is an inherently content focused model while all of the others, both in Morgan's framework and presented

here, are intrinsically process-focused. The ‘container’ metaphor could also be considered as a form of organism or prison and in this way coincide with Morgan’s framework.

- *System:* if a VLE is a system then this raises questions of purpose, interactions and structure. Analyses could be made along the lines of Checkland’s criteria (see the previous section) or they could use models such as those developed at the Open University of the Netherlands for instructional design (van Merriënboer, Bastians et al., 2004). The ‘system’ metaphor can be seen as coincident with Morgan’s metaphors of brains, cultures and flux.

There are therefore other metaphors that could be used as a starting point for investigating VLEs-in-use although they are likely to overlap those already used to some extent or other. Alternative metaphor frameworks for multiple methods inquiry have not been explored in this thesis, but it would be a suitable subject of future work.

12.4: Conclusions

> *“The environment that people live in is the environment that they learn to live in, respond to, and perpetuate. If the environment is good, so be it. But if it is poor, so is the quality of life within it.” Ellen Swallow Richards (1842-1911), pioneering US chemist and ecologist*

Ellen Richards warned us to be aware of the quality of life our environments afford us. Although as a pioneer ecologist she was writing about the natural environment, her concerns are equally valid for more abstract or intangible environments such as those that are created by our social and technical processes, and in particular, those we create or extend by use of new technologies as represented by virtual learning environments. Despite this, research into VLE use at a single large programme of study or cognate discipline level is largely absent from the literature and in-depth studies are particularly lacking:

> *“the state of the art in evaluation of the use of VLEs in Higher Education is a matter of ‘under-use’ rather than under-theorising … it is unlikely that teaching and learning using VLEs in Higher Education will become more efficient and effective without significant applied research and evaluation” (Konrad, 2003)*

This thesis has sought to address this by undertaking an in-depth look at evaluating the VLE in use at the University of Edinburgh to support undergraduate medical students, their teachers and the many other support staff involved in the learning environment as a whole. The following is provided both as a summary for this thesis and as a suggestion for how this work might be developed further.

12.4.1: Research

It has been shown that the utility of a VLE really only emerges when it is being used in context. Despite the tautology, it is an important point, as VLE evaluation and theorising in the literature has tended to focus on VLEs-in-abstract (Britain and Liber, 2004a; Jochems, van Merriënboer et al., 2004). This perhaps reflects the increasingly managerialist uses to which VLEs are being put as single-institution one-size-fits-all solutions, often to poorly defined problems. Although the criticality of use is probably true for any technology, it is a particular issue for systems like VLEs because of their integrated structure and context-spanning scope, and because of the plurality and divergence of their users' experiences. Moreover, the use of VLEs in blended mode (augmenting face-to-face core activities) can quite profoundly change the nature of the whole learning environment:

> *"the virtual … introduces multiplicity into the otherwise fixed category of the real. As such the tangible, actually real phenomena cease to be the sole, hegemonic examples of 'reality'" (Shields, 2003, p21)*

Multiple methods approaches to research and evaluation have been shown to be an appropriate way of exploring the new extended learning environments that are created by using VLEs. Furthermore, the use of metaphors has also been shown to be a powerful way of framing multiple methods investigations:

> *"the metaphors and analogies we find attractive are laden with cultural values and expectations that come from outside our science. They inevitably reflect our experience … those who deny this … are at best unselfreflective" (Rose, 1997, p68)*

Metaphor frameworks do not provide the methods of inquiry on their own. There is a strong element of researcher interpretation and creativity associated with developing appropriate methods that fit both the metaphor framework and the research subject. Ethnographic principles of participation and engagement are therefore also important as the researcher must either have or develop an intimate understanding of the context of study.

12.4.2: Future Developments

The principles and much of the technology developed for EEMeC have been repurposed and redeveloped to serve different educational contexts. In 2001 a VLE for undergraduate veterinary medicine was launched as 'EEVeC' and in 2004 a third variant was set up for all of the College's postgraduate community and called 'EEPoP'. Other systems derived from EEMeC include 'eScript' a VLE for postgraduate law students in Edinburgh and a range of 'collaborative work environments' that support research projects with members in different institutions. These and other ongoing technology and systems developments based on EEMeC have been shaped by the outputs of this research and will continue to develop along lines of better evidence-based practice as a result.

There have been a number of suggestions throughout the thesis for how individual evaluation components and techniques might be further developed. For instance the Learning Architecture Framework (LAF) instrument could be developed further to firm up the mappings between theory and practice, to establish whether different kinds of systems do demonstrate different LAF profiles and to investigate whether these mappings can typify VLEs in a meaningful way. The use of common methods such as those from ‘network theory’ (Lazega, 1997), might provide means to both triangulate and validate multiple methods

There should be further investigation into the development and use of different metaphor-based evaluation frameworks both regarding VLEs and in general. Certainly it has been clear that this research has been as much about how the learning environment is constructed in general as it has about the use of a VLE. More work should also be done on revealing the ways that VLEs are actually being used. This should acknowledge that pedagogy is often just one factor among many and often not the most important. Perhaps we should talk about ‘virtual teaching environments’ or use more honest terms such as ‘course management systems’ in these circumstances. Language and metaphor do after all shape the way we perceive and react to the world around us. Since VLEs are provided by institutions and are not chosen by the learner (and often not by the teacher either), there are further issues over politics and constraints associated with such systems as well as benefits and opportunities.

The way that VLEs can reflect prior structures and arrangements was discussed in chapter nine. Further research into these antecedents and assumptions that shape online learning environments would be another area warranting further research.

The methods and techniques developed throughout this thesis provide both a substantial contribution to the healthcare education and learning technology communities, and a challenge to the way these communities see themselves, their actions and the way they interact with each other. This work has also extended the consideration of the VLE and learning environments in general from one focused on teaching and learning to a far broader conception of what constitutes contemporary learning environments and how technologies are constructed and function within them. More importantly, perhaps, it has exposed much that is hidden, disregarded or even unpalatable regarding the use of VLEs in medical education. The biggest contribution however has been the provision of an encompassing and holistic view of a whole learning environment and the VLE that has been developed and used within it. As such there is much that can be taken from this work and applied elsewhere and there is much that it can do in stimulating reflection on and deeper consideration of the use of technology in medical education and beyond.

12.4.3: Summary

This thesis has undertaken a holistic review of a comprehensive technologically based educational support system being used and shaped by its use in a particular educational context, that of undergraduate medicine at the University of Edinburgh. The use of formative evaluation methodologies identified a number of improvements and changes that need to be made to EEMeC and the way it is run and used. But on a wider stage this work has also been able to identify and draw together a number of other key themes.

The dynamics of medical education in the UK at the start of the 21^{st} century have provided many of the contextual drivers that have led to the development of EEMeC and the way it has been used and perceived by its users. In a few short years EEMeC has moved from an innovatory experiment to become a mainstay of the Edinburgh MBChB, echoing the rapid adoption of learning technologies in medical education as a whole (Ward, Gordon et al., 2001).

EEMeC has been shown to have been particularly successful because of its alignment with its context of use, the ways in which its users have been involved in its development and its adaptability to change over time. This approach, although successful, has by necessity been conservative in that it has been evolutionary rather than revolutionary. This is also reflected in the way in which EEMeC has been shaped by prior practices and assumptions within the Edinburgh MBChB's learning environment.

This study has also identified a number of broader issues for learning technology research in general:

- There is a diversity of experience and perception of, and benefit from using a VLE for its different users. In particular, students may perceive and value it in quite different ways from staff and sometimes contrary to staff expectations.
- Holism is important when considering a VLE. It impacts on and interacts with all aspects of the learning environment. In particular pedagogical benefit or efficacy may not be where the advantages and disadvantages of using a VLE may occur.
- Considering contextualised use of technology is different from considering technology out of context. Although a VLE-in-abstract may be considered quite objectively, in use it is inevitably reconstructed along non-rational social, cultural and political lines.
- Paradigmatic approaches to research and evaluation can be informed by using metaphors as theoretical lenses. Metaphors, as a familiar cognitive device can stimulate new ways of looking at the world and of structuring questions and inquiry about it.

Despite its success, EEMeC cannot last forever. It has been introduced at a time when almost every aspect of the learning environment is in flux. Organisational, political, professional, technical and social forces are changing the face of undergraduate medical education and EEMeC is both a driver of and a response to these changes. It remains particularly visible at the moment (despite its virtuality) because of the novelty of what the technology is able to do.

The most important aspect of this research has therefore been inquiring about the nature of learning environments in general and the ways in which they can be supported and structured by technological means. What the long-term result of enterprises like EEMeC will be on the quality of medical students' learning and thereby on patient welfare has yet to be seen. What can be said is that developing and using EEMeC has led to a number of significant changes to the way medical education is supported and run in Edinburgh.

References

Agre, P. E. (1997). "Computing as a Social Practice". Reinventing Technology, Rediscovering Community: critical explorations of computing as a social practice. Agre, P. E. and Schuler, D. Greenwich, CT, Ablex Publishing Corporation.

Agre, P. E. (1999). "The Distances of Education." Academe 85(5): 37-41

Agre, P. E. (2002). "Infrastructure and Institutional Change in the Networked University". Digital Academe. Dutton, W. H. and Loader, B. D. London, Routledge: 152-166.

Alexander, W., Broadhurst, J. and Ellaway, R. (2003). "Meeting Across the Metadata Divide." Assignation 21(1): 13-16

Alkin, M. C. (1990). "Debates on Evaluation". Newbury Park, CA, SAGE

Allen, M. T. and Hecht, G., Eds. (2001). "Technologies of Power". Boston, MA, The MIT Press.

Alrajeh, N. and Janco, B. (1998). "A Model for Asynchronous Learning Networks in Medical Education?" 2(2). http://www.aln.org/alnweb/magazine/vol2_issue2/nabil.htm

Alsop, G. and Tompsett, C. (2004). "Should the Use of Different Research Models for Networked Learning Lead to Different Results?" Networked Learning 2004, Sheffield

Ambler, S. W. (2004). "Be Realistic About the UML." http://www.agilemodeling.com/essays/realisticUML.htm, accessed 19 August 2004

American Society for Cybernetics "Defining Cybernetics." http://www.asc-cybernetics.org/foundations/definitions.htm accessed 8th February 2005

Apple Computer Inc (1996). "Macintosh Human Interface Guidelines." http://developer.apple.com/documentation/mac/pdf/HIGuidelines.pdf accessed 3 January 2005

Argyris, C. and Schon, D. A. (1978). "Organizational Learning: a theory of action perspective ". USA, Addison-Wesley

Atkinson, P. and Hammersley, M. (1998). "Ethnography and Participation Observation". Strategies of Qualitative Enquiry. Denzin, N. K. and Lincoln, Y. S., Sage: 110-136.

Axup, J. (n/a). "Comparison of Usability Evaluation Methods (UEMs)." http://www.userdesign.com/usability_uem.html accessed 5 November 2004

Barajas, M. and Owen, M. (2000). "Implementing virtual learning environments: looking for holistic approach." Educational Technology and Society 3(3). http://ifets.gmd.de/periodical/vol_3_2000/barajas.html

Basili, V. R. and Weiss, D. (1984). "A Methodology for Collecting Valid Software Engineering Data." IEEE Transactions on Software Engineering 10(6): 728-738

Beynon-Davies, P. (1996). "Database Systems". UK, Macmillan Press Ltd

Biggs, J. (1999). "Teaching for Quality Learning". UK, OU Press

Blackboard Inc (2001). "Blackboard Course and Portal Solutions"

Blackboard Inc (2002). "BlackBoard Learning System ML brochure"

Blackmore, S. (1999). "The Meme Machine". Oxford, UK, Oxford University Press

Bloor, M. (1997). "Techniques of Validation in Qualitative Research: a Critical Commentary". Context and Method in Qualitative Research. Miller, G. and Dingwall, R. London, SAGE.

Booch, G., Rumbaugh, J. and Jacobson, I. (1999). "The Unified Modelling Language User Guide". Indianapolis, Addison-Wesley

Boyle, T. and Cook, J. (2004). "Understanding and using technological affordances: a commentary on Conole and Dyke." ALT-J 12(3): 295-300

Britain, S. and Liber, O. (1999). "A Framework for Pedagogical Evaluation of Virtual Learning Environments (JTAP Report 041) ". UK, JTAP

Britain, S. and Liber, O. (2004). "The Pedagogical Evaluation of Virtual Learning Environments (2nd edition)"

Bromley, H. (1997). "Thinking About Computers and Schools: A Skeptical View". Reinventing Technology, Rediscovering Community: critical explorations of computing as a social practice. Agre, P. E. and Schuler, D. Greenwich, CT, Ablex Publishing Corporation: 107-126.

Brown, J. S. and Duguid, P. (1995). "Universities in the Digital Age." www2.parc.com/ops/members/brown/papers/university.html accessed 18/1/2004

Brown, J. S. and Duguid, P. (2000). "The Social Life of Information ". USA, Harvard Business School Press

Browne, T. and Jenkins, M. (2003). "VLE Surveys: a longitudinal perspective between March 2001 and March 2003 for Higher Education in the United Kingdom". UK, UCISA. http://www.ucisa.ac.uk/groups/tlig/vle/vle2003.doc

Cardwell, D. (1994). "The Fontana History of Technology". London, UK, Fontana Press

Carroll, J. M., Kellogg, W. A. and Rosson, M. B. (1991). "The Task-Artifact Cycle". Designing interaction: psychology at the human-computer interface. Carroll, J. M. Cambridge UK, Cambridge University Press.

Chalk, P. D. (2001). "Learning Software Engineering in a Community of Practice - A Case Study". CAL2001, Warwick. http://www.ics.ltsn.ac.uk/pub/conf2001/papers/Chalk.htm accessed 20 June 2003

Checkland, P. (1981). "Systems Thinking, Systems Practice", John Wiley & Sons

Chia, R. (1996). "Metaphors and metaphorization in Organizational Analysis: Thinking Beyond the Thinkable". Metaphor and Organizations. Grant, D. and Oswick, C. London, Sage: 127-145.

Clark, D. (2003). "Blended Learning". Brighton, EPIC Group PLC

Clarke, A. (1999). "Evaluation Research". London, SAGE

Cohen, L., Manion, L. and Morrison, K. (2000). "Research Methods in Education". UK, Routledge

Collins, T. and Bicknell, D. (1997). "Crash: learning from the world's worst computer disasters". UK, Simon & Schuster

Conole, G. and Dyke, M. (2004). "Understanding and using technological affordances: a response to Boyle and Cook." ALT-J 12(3): 301-308

Conole, G., Oliver, M. and Harvey, J. (2000). "Toolkits as approaches to evaluating and using learning materials". ASCILITE

Conole, G., Oliver, M., Isroff, K. and Ravenscroft, A. (2004). "Addressing Methodological Issues in e-Learning Research". Networked Learning 2004, Sheffield

Cook, J. (2001). "JTAP 623 - The Role of Virtual Learning Environments in UK Medical Education". UK, Institute for Learning and Research Technology

Cook, J. (2005). "Virtual Learning Environments in UK Medical Education: LTSN-01 Mini-project report", LTSN-01

Cooper, A. (2004). "The Inmates are Running the Asylum: Why High Tech Products Drive Us Crazy and How to Restore the Sanity". USA, Sams Publishing

Cornford, J. and Pollock, N. (2003). "Putting the university online: information, technology and organizational change". UK, Open University Press

Coyne, R. (1995). "Designing Information Technology in the Postmodern Age: from method to metaphor". Boston, MA, MIT Press

Cresswell, J. W. (2003). "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches". London, Sage

Crook, C. (1994). "Computers and the Collaborative Experience of Learning". UK, Routledge

Davies, R. (2004). "Scale, Complexity and the Representation of Theories of Change." Evaluation 10(1): 101-121

Davis, j. and Merritt, S. (1998). "The Web Design Wow! Book: Showcasing the Best of On-Screen Communication". Berkeley, CA, Peachpit Press

Denzin, N. K. (1978). "The Research Act: a theoretical introduction to sociological methods". USA, McGraw-Hill

Dewhurst, D. and Ellaway, R. (2005). "Virtual Learning Environments". Practical Guide for Medical Teaching (in press). Dent, J., Churchill Livingstone.

Draper, S. (1996). "Observing, Measuring, or Evaluating Courseware." http://www.psy.gla.ac.uk/~steve/Eval.HE.html accessed 18th December 2005

Dreyfus, H. L. (2001). "On the Internet". UK, Routledge

Dutton, W. H. and Loader, B. D., Eds. (2002). "Digital Academe: the New Media and Institutions of Higher Education and Learning". London, UK, Routledge.

Ellaway, R., Begg, M., Dewhurst, D. and MacLeod, H. (2005). "In a Glass Darkly: identity, agency and the role of the learning technologist in shaping the learning environment". ICE2 Proceedings (Cumbria), Edinburgh, UK http://www.malts.ed.ac.uk/ice2/abstracts/ellaway.htm accessed 20 December 2005

Ellaway, R., Cameron, H. and Dewhurst, D. (2002). "A Framework for Analysing Determinism in Educational Practice when Using Learning Technology". ALT-C 2002 Proceedings (Sunderland), ALT, Oxford, UK

Ellaway, R., Dewhurst, D. and Cameron, H. (2002). "Do no harm: revealing technological determinism in educational practice." SRHE 2002 Proceedings (Glasgow), Milton Keynes, UK

Ellaway, R., Dewhurst, D. and Cameron, H. (2003a). "Developing critical approaches to the impact of technology in medical education". ASME 2003 Proceedings (Edinburgh), ASME, Edinburgh, UK

Ellaway, R., Dewhurst, D. and Cumming, A. (2003b). "Managing and supporting medical education with a virtual learning environment - the Edinburgh Electronic Medical Curriculum." Medical Teacher 25(4): 372-380

Ellaway, R., Dewhurst, D. and McLeod, H. (2004). "Evaluating a virtual learning environment in the context of its community of practice." ALT-J 12(2): 125-145

Ellaway, R., Mogey, N. and Alexander, W. (2002). "Locating Service Provision in an Organisational Context: a framework for exploring the orientation of educational services". SRHE 2002 Proceedings (Glasgow), Milton Keynes, UK

Ellaway, R. H., Dewhurst, D. G. and Douglas, P. (2001a). "The Difference that Makes the Difference: challenging the generic VLE course model". ALT-C 2001 Proceedings (Edinburgh), ALT, Oxford, UK

Ellaway, R. H., Dewhurst, D. G. and Douglas, P. (2001b). "Implementing a Virtual Learning Environment (VLE) for a Medical Curriculum." LTSN Bioscience Bulletin (Spring 2001)

Ellaway, R. H., Mogey, N. and Alexander, W. (2001). "Learning Technology Development and Deployment: exploring the influence of the orientation and alignment of learning technology services within an institution". ALT-C 2001 Proceedings (Edinburgh), ALT, Oxford, UK

Entwistle, N. (1984). "Contrasting Perspectives on Learning". The Experience of Learning. Marton, F., Hounsell, D. and Entwistle, N. Edinburgh, UK, Scottish Academic Press: 3-22.

Entwistle, N. (2003). "University Teaching-Learning Environments and Their Influences on Student Learning: An Introduction to the ETL Project". EARLI Conference, Padova

Entwistle, N., McCune, V. and Hounsell, J. (2002). "Approaches to Studying and Perceptions of University Teaching-Learning Environments: Concepts, Measures and Preliminary Findings". Edinburgh, ETL Project, The University of Edinburgh

Fenton, N. E. and Pfleeger, S. L. (1997). "Software Metrics: a Rigorous and Practical Approach". Boston MA, PWS Publishing Company

Follows, S. B. (1999). "Virtual Learning Environments." Technological Horizons in Education Journal Online. http://www.thejournal.com/magazine/vault/articleprintversion.cfm?aid=2374

Ford, P., Goodyear, P., Hesletine, R., Lewis, R., Darby, J., Graves, J., Sartorius, P., Harwood, D. and King, T. (1996). "Managing Change in Higher Education - a learning environment architecture". UK, OUP

Foucault, M. (1975). "Discipline and Punish: the birth of the prison", Penguin

Fowler, M. (2004). "UML Distilled". Boston, USA, Addison-Wesley

Franklin, T., Armstrong, J., Oliver, M. and Petch, J. (2004). "Towards an Effective Framework for the Evaluation of e-Learning", The e-Learning Research Centre, The University of Manchester

Friedman, B. and Kahn, P. H. (2003). "The Ethics of System Design". Computers, Ethics and Society. Ermann, M. D. and Shauf, M. S. Oxford, Oxford University Press: 55-63.

Friedman, B. and Nissenbaum, H. (1997). "Bias in Computing Systems". Human Values and the Design of Computer Technology. Friedman, B. Cambridge, Cambridge University Press: 21-40.

Gibson, J. J. (1979). "The Ecological Approach to Visual Perception". USA, Houghton Mifflin

Glaser, B. and Strauss, A. (1967). "Discovery of Grounded Theory". Chicago, USA, Aldine

Goldberg, J. (1995). "Why web usage statistics are (worse than) meaningless." http://www.goldmark.org/netrants/webstats/ accessed 23 December 2003

Goodyear, P. (1997). "The ergonomics of learning environments: learner-managed learning and new technology". EDUTEC '97 (3rd Congress on New Information Technologies for Learning), Malaga, Spain

Graham, G. (1999). "The Internet://a philosophical enquiry", Routledge

Grant, D. and Oswick, C., Eds. (1996). "Metaphor and Organizations". London, Sage.

Greenhalgh, T. (2001). "Computer assisted learning in undergraduate medical education", British Medical Journal 322, 40-44

Greif, S. (1991). "The Role of German Work Psychology in the Design of Artifacts". Designing interaction: psychology at the human-computer interface. Cambridge UK, Cambridge University Press.

Hale, C. E. (1996). "Wired Style: principles of English usage in the digital age ". USA, Hardwired

Hall, E. T. (1959). "The Silent Language". USA, Anchor Books

Hall, E. T. (1976). "Beyond Culture". USA, Anchor Books

Hamilton, N. M., Furnace, J., P, D. K., J, H. P. and G, S. J. (1999). "Development and integration of CAL: a case study in medicine", Medical Education 33, 298-305

Hammersley, M. and Atkinson, P. (1995). "Ethnography: Principles in Practice". London, Routledge

Hannan, A. and Silver, H. (2000). "Innovating in Higher Education: teaching, learning and institutional cultures". UK, OUP

Harris, N. (2001). "Managed Learning?" ARIADNE(30). www.ariadne.ac.uk/issue30/angel/intro.html

Harvey, J., Ed. (1998). "Evaluation Cookbook". Edinburgh, UK, LTDI.

Healy, J. M. (1998). "Failure to Connect - how computers affect our children's minds ". USA, Simon and Schuster

Hecht, G. and Allen, M. T. (2001). "Authority, Political Machines, and Technology's History". Technologies of Power. Boston MA, The MIT Press: 1-23.

Heidegger, M. (1978). "The question concerning technology". Basic writings, Routledge: 311-341.

Hills, H. (2003). "Individual Preferences in e-Learning". Aldershot, UK, Gower Publishing Limited

Huber, J. T. (1999). "Efficiency and Effectiveness Measures To Help Guide the Business of Software Testing", Hewlett Packard Company. http://www.benchmarkqa.com/PDFs/efficiency_measures.pdf accessed 12 October 2004

Hunt, M., Parsons, D. and Fleming, A. (2003). "A review of the research literature on the use of managed learning environments in education, and a consideration of the implications for schools in the United Kingdom". UK, BECTA

Ingraham, B., Watson, B., McDowell, L., Brockett, A. and Fitzpatrick, S. (2002). "Evaluating and implementing learning environments: A United Kingdom experience." Educational Technology Review 10(2): 28-51

Izwaini, S. (2003). "A corpus-based study of metaphor in information technology". Corpus Linguistics 2003, Lancaster University (UK), Centre for Computational Linguistics, UMIST

Jenkins, M., Browne, T. and Armitage, S. (2001). "Management and Implementation of Virtual Learning Environments: a UCISA funded survey". UK, UCISA.

JISC (2001). "Managed Learning Environments Information Pack". UK, JISC

Jochems, W., van Merriënboer, J. and Koper, R., Eds. (2003). "Integrated e-Learning: implications for pedagogy, technology and organization". Open & Flexible Learning. London, UK, RoutledgeFalmer.

Johnson, S. (1997). "Interface Culture: how new technology transforms the way we create and communicate". USA, Basic Books

Jones, C. (2004). "Quantitative and Qualitative Research: Conflicting Paradigms or Perfect Partners?" Networked Learning Conference 2004, Sheffield, UK

Knights, D. and Murray, F. (1997). "Markets, Managers and Messages: Managing Information Systems in Financial Services". Information Technology and Organizations: Strategies, Networks and Integration. Bloomfield, B. P., Coombs, R., Knights, D. and Littler, D. Oxford University Press: 36-56.

Knights, D., Noble, F. and Willmott, H. (1997). "'We Should Be Total Slaves To The Business': Aligning Information Technology and Strategy - Issues and Evidence". Information Technology and Organizations: Strategies, Networks and Integration. Bloomfield, B. P., Coombs, R., Knights, D. and Littler, D. Oxford, Oxford University Press: 13-35.

Knowledge and Research Programme on Disability and Healthcare Technology (2004). "Constructing a Logical Framework." http://www.kar-dht.org/logframe.html 30 December 2004

Konrad, J. (2003). "Review of educational research on virtual learning environments [VLE] - implications for the improvement of teaching and learning and access to formal learning in Europe". European Conference on Educational Research, Hamburg, Germany. http://www.leeds.ac.uk/educol/documents/00003192.htm accessed 16 November 2003

Koper, R. (2000). "From change to renewal: Educational technology foundations of electronic learning environments". Netherlands, Open University of the Netherlands. http://eml.ou.nl/introduction/docs/koper-inaugural-address.pdf accessed 23 May 2003

Krug, S. (2000). "Don't Make Me Think: a common sense approach to web usability ". USA, Circle.com Library

Kukulska-Hulme, A. and Shield, L. (2004). "The Keys to Usability in e-Learning Websites". Networked Learning Conference 2004, Sheffield, UK

Lakoff, G. and Johnson, M. (1980). "Metaphors we live by". Chicago, University of Chicago Press

Land, R. and Bayne, S. (2004). "Screen or Monitor? Surveillance and disciplinary power in online environments". Education in Cyberspace. Land, R. and Bayne, S. London, Routledge.

Landauer, T. K. (1995). "The trouble with computers: usefulness, usability, and productivity". USA, MIT Press

Laurillard, D. (1993). "Rethinking University Teaching - A framework for the effective use of educational technology". UK, Routledge

Lave, J. and Wenger, E. (1991). "Situated Learning: legitimate peripheral participation". Cambridge, UK, Cambridge University Press

Lawler, J. M. (1999). "Metaphors We Compute By." http://www-personal.umich.edu/~jlawler/meta4compute.html accessed 7 April 2004

Lazega, E. (1997). "Network Analysis and Qualitative Research: a Method of Contextualisation". Context and Method in Qualitative Research. Miller, G. and Dingwall, R. London, Sage.

Lee, M. and Thompson, R. (1999). "Teaching at a Distance: Building a Virtual Learning Environment (JTAP 033)". UK, JTAP. http://www.jisc.ac.uk/uploaded_documents/jtap-033.doc

Lincoln, Y. S. and Guba, E. G. (1985). "Naturalistic Inquiry". USA, SAGE

Lisewski, B. and Joyce, P. (2003). "Examining the five-stage e-moderating model: designed and emergent practice in the learning technology profession." ALT-J 11(1): 55-66

Littlejohn, A. H., Ed. (2003). "Reusing online resources: a sustainable approach to e-learning". Open & flexible learning, Kogan Page.

Littlejohn, K. and Light, P. E. (1999). "Learning with Computers"

Lucas, C. (2000). "Fitness and Synergy." http://www.calresco.org/lucas/fitness.htm 28 August 2004

MacKenzie, D. and Wajcman, J., Eds. (1999). "The Social Shaping of Technology", Open University Press.

Mander, J. (1994). "Tyranny of Technology." Resurgence(164)

Mangham, I. L. (1996). "Some Consequences of Taking Gareth Morgan Seriously". Metaphor and Organizations. Grant, D. and Oswick, C. London, Sage: 21-36.

Marton, F., Hounsell, D. and Entwistle, N., Eds. (1997). "The Experience of Learning - implications for Teaching and Studying in Higher Education". Edinburgh, UK, Scottish Academic Press.

Massey, A. (1999). "Methodological Triangulation, or how to get lost without being found out". Explorations in Methodology: studies in educational ethnography, volume 2. Massey, A. and Walford, G. Stamford, JAI Press: 183-197.

McCabe, T. J. (1976). "A Complexity Measure." IEEE Transactions on Software Engineering SE-2(4): 308-320

McDonald, A., Ellaway, R., Davies, D. and Cook, J. (2005). "FMSC Interoperability Project", The University of Newcastle

McDonald, A., Quentin-Baxter, M., Ellaway, R., Davies, D., Byrne, D. and Skelly, G. (2005). "TLTP3-86 Network Learning in Medicine and Health Sciences Transferability/Interoperability Project Report", The University of Newcastle

McGrenere, J. and Ho, W. (2000). "Affordances: Clarifying and Evolving a Concept ". Graphics Interface 2000, Montreal

McLoughlin, I. (1999). "Creative technological change: the shaping of technology and organisations". London, UK, Routledge

Melia, K. M. (1997). "Producing 'Plausible Stories': Interviewing Student Nurses". Context and Method in Qualitative Research. Miller, G. and Dingwall, R. London, Sage.

Miles, M. B. and Huberman, A. M. (1994). "Qualitative Data Analysis". London, Sage

Milligan, C. (1999). "Virtual Learning Environments in the Online Delivery of Staff Development (JTAP 44) ". UK, JTAP

Morgan, G. (1996). "Is there anything more to be said?" Metaphor and Organizations. Grant, D. and Oswick, C. London, Sage: 227-240.

Morgan, G. (1997). "Images of Organization". USA, Sage

Nardi, B. A. and O'Day, V. L. (1999). "Information ecologies: using technology with heart", MIT Press

Nielsen, J. (1994). "Ten Usability Heuristics." http://www.useit.com/papers/heuristic/heuristic_list.html accessed 28 November 2004

Nielsen, J. (1999). "Designing Web Usability". USA, New Riders

Nissenbaum, H. (1997). "Accountability in a Computerized Society". Human Values and the Design of Computer Technology. Friedman, B., CSLI/Cambridge University Press: 41-64.

Norman, D. A. (1988). "The Design of Everyday Things". USA, MIT Press

Norman, D. A. (1991). "Cognitive Artifacts". Designing Interaction: psychology at the human-computer interface. Carroll, J. M. Cambridge, UK, Cambridge University Press.

Norman, D. A. (1999). "The Invisible Computer". USA, MIT Press

Notess, M. and Plaskoff, J. (2004). "Preliminary heuristics for the design and evaluation of online communities of practice systems." http://www.elearnmag.org/subpage/sub_page.cfm?section=4&list_item=8&page=1 7 March 2004

Object Management Group (2004). "Introduction To OMG's Unified Modeling Language (UML)." http://www.omg.org/gettingstarted/what_is_uml.htm accessed 19 August 2004

Oliver, M. (1998). "Innovation in the Evaluation of Learning Technology", University of North London

Oliver, M. (2000). "An Introduction to the Evaluation of Learning Technology", Educational Technology and Society 4, 3. http://ifets.ieee.org/periodical/vol_4_%D 2000/intro.html

Oliver, M. (2001). "What's the Purpose of Theory in Learning Technology? (ALT Special Interest Group for Theory and Learning Technology Positional Paper)." http://homepages.unl.ac.uk/%7Ecookj/alt_lt/Oliver.htm accessed 17 January 2004

Oliver, M. and Conole, G. (1998). "The evaluation of learning technology - an overview". Innovation in the evaluation of learning technology. Oliver, M. London, UK, University of North London.

Oliver, M., Frances, R., Duggleby, J., Jennings, D., Kay, D. and Hughes, G. (2004). "Consultation with learning technologists, employers and sector representatives on the development of an accreditation scheme. ALT Accreditation project report no. 3." http://www.ucl.ac.uk/calt/alt-accreditation/Consultation%20with%20lts%20final.doc accessed 16 January 2005

Oliver, M. and Harvey, J. (2002). "What does 'impact' mean in the evaluation of learning technology?" Educational Technology & Society 5(3)

Oppenheim, A. N. (1996). "Questionnaire Design, Interviewing and Attitude Measurement". USA, Continuum

Pacey, A. (1999). "Meaning in Technology". Cambridge MA, USA, MIT Press

Patton, M. Q. (1986). "Utilization-focused evaluation". USA, Sage

Perrolle, J. R. (1987). "Computers and Social Change: Information, Property and Power". California USA, Wadsworth

Pool, R. (2003). "A History of the Personal Computer". Computers, Ethics and Society. Ermann, M. D. and Shauf, M. S. Oxford, Oxford University Press: 91-100.

Popkewitz, T. S. (1984). "Paradigm and Ideology in Educational Research". Brighton, The Falmer Press

Postman, N. (1992). "Technopoly: the surrender of culture to technology". USA, Vintage

Preece, J., Sharp, H., Benyon, D., Holland, S. and Carey, T. (1994). "Human-Computer Interaction". UK, Addison-Wesley

Pulkkinen, J. (2003). "The Paradigms of E-Education: an analysis of the communication structures in the research on information and communication technology integration in education in the years 2000-2001". Ouklu, Finland, OULU

Quentin-Baxter, M., Hammond, G. and Jordan, R. (1999). "Facilitated Network Learning in Medicine and Health Sciences (Summary of TLTP3-86", CTICM Update

Reiser, S. J. (1978). "Medicine and the Reign of Technology". Cambridge, Cambridge University Press

Richardson, J. A. and Turner, A. (2000). "A Large-scale 'local' evaluation of students' learning experiences using virtual learning environments ", Educational Technology and Society 3, 4 http://ifets.gmd.de/periodical/vol_4_2000/richardson.html accessed 7 January 2005

Roberts, T. (2002). "Disabled students - disabled doctors - time for a change?" LTSN-01. http://www.ltsn-01.ac.uk/resources/proposals/miniprojs2/miniproj2_details/roberts accessed 19 January 2005

Robson, C. (1993). "Real World Research ". UK, Blackwell

Rogers, E. M. (1995). "Diffusion of Innovations". New York, USA, The Free Press

Rogers, J. (2000). "Communities of practice: a framework for fostering coherence in virtual learning communities." Educational Technology & Society 3(3)

Rose, S. (1997). "Lifelines: biology, freedom, determinism". London, Penguin

Roszak, T. (1994). "The Cult of Information: a neo-luddite treatise on high-tech, artificial intelligence, and the true art of thinking". USA, University of California Press

Sauer, C. (1993). "Why Information Systems Fail: A Case Study Approach". UK, Alfred Waller Ltd

Scanlon, E., Jones, A., Barnard, J., Thompson, J. and Calder, J. (2000). "Evaluating information and communication technologies for learning." Educational Technology & Society 3(4)

Scarborough, H. and Corbett, J. M. (1992). "Technology and organization: power, meaning and design ". UK, Routledge

Schneier, B. (2004). "Secrets and Lies: digital security in a networked world", Wiley

Schwen, T. M. and Hara, N. (2003). "Community of Practice: A Metaphor for Online Design?" The Information Society 19: 257-270

Schwier, R. A. (2002). "Shaping the Metaphor of Community in Online Learning Environments". International Symposium on Educational Conferencing, The Banff Centre, Banff, Alberta. http://cde.athabascau.ca/ISEC2002/papers/schwier.pdf accessed 3 April 2004

Scott, D. (2001). "Situated Views of Learning". Learning, Space and Identity. Paechter, C., Edwards, R., Harrison, R. and Twining, P., Paul Chapman Publishing.

Seale, C. (1999). "The Quality of Qualitative Research". UK, Sage Publications

Shields, R. (2003). "The Virtual". London, Routledge

Snyder, B. R. (1971). "The Hidden Curriculum". USA, MIT Press

Stiles, M. (2000). "Effective Learning and the Virtual Learning Environment". EUNIS 2000, Poznan, Poland, IIPP

Stiles, M. (2001). "Pedagogy and Virtual Learning Environment (VLE) Evaluation and Selection". London, UK, JISC

Strauss, A. and Corbin, J. (1998a). "Basics of qualitative research: techniques and procedures for developing grounded theory". USA, Sage

Strauss, A. and Corbin, J. (1998b). "Grounded Theory Methodology". Strategies of Qualitative Enquiry. Denzin, N. K. and Lincoln, Y. S., Sage: 158-183.

Strum, S. and Latour, B. (1999). "Redefining the social link: from baboons to humans". The Social Shaoping of Technology. MacKenzie, D. and Wajcman, J. Maidenhead, Open University Press: 116-125.

Tansey, S. D. (2004). "Politics: The Basics". London, UK, Routledge

Tashakkori, A. and Teddlie, C. (1998). "Mixed Methodology: Combining Qualitative and Quantitative Approaches". Thousand Oaks, CA, SAGE

Tenner, E. (1996). "Why things bite back: predicting the problems of progress", Fourth Estate

Tergan, S. (1998). "Checklists for the Evaluation of Educational Software: Critical Review and Prospect." Innovations in Education and Training International 35(1): 9-20

The University of Edinburgh (2004). "Annual Report 2003-2004". Edinburgh, The University of Edinburgh

Trompenaars, F. and Hampden-Turner, C. (1997). "Riding the Waves of Culture: understanding cultural diversity in business". London, Nicholas Brealey Publishing

Tsoukas, H. (1993). "Analogical Reasoning and Knowledge Generation in Organization Theory." Organization Studies 14(3): 323-346

Tuchman, G. (1998). "Historical Social Science: Methodologies, Methods and Meanings". Strategies of Qualitative Inquiry. Denzin, N. K. and Lincoln, Y. S. Thousand Oaks, Sage: pp225-260.

Tynan, A. (2002). "Pushing the boat out: An introductory study of admissions to UK medical, dental & veterinary schools for applicants with disabilities", LTSN-01. http://www.ltsn-01.ac.uk/ltsn_images/pdfs/ptbo_final.pdf accessed 12 January 2005

van Merriënboer, J., Bastians, T. and Hoogveld, A. (2004). "Instructional design for integrated e-learning". Integrated e-Learning. Jochems, W., van Merriënboer, J. and Koper, R. London, Routledge Farmer: 13-23.

Vang, J. (1994). "The Case of Medicine". Governments and Professional Education. Becher, T., Open University Press.

Various (Wikipedia) (2004). "Use case." http://en.wikipedia.org/wiki/Special:Search?search=use+case&go=Go 28 October 2004

W.K. Kellogg Foundation (2001). "Using Logic Models to Bring Together Planning, Evaluation, & Action Logic Model Development Guide", W.K. Kellogg Foundation

Ward, J. P. T., Gordon, J., Field, M. J. and Lehman, H. P. B. (2001). "Communication and Information Technology in Medical Education." The Lancet (357): 792-796

Watts, D. J. (2003). "Six Degrees: the science of a connected age". London, Vintage

WebCT Inc (2003). "Transforming the Educational Experience." http://www.webct.com/company accessed 2 May 2004

Weinburg, G. M. (1975). "An Introduction to General Systems Thinking". New York, John Wiley & Sons

Weiss, C. H. (1988). "If Program Decisions Hinged Only on Information." Evaluation Practice 9(2): 87-92

Wenger, E. (1998). "Communities of Practice", Cambridge University Press

Wilcox, P., Dexter, H. and Petch, J. (2004). "A Foundation for Modelling e-Learning Processes", The e-Learning Research Centre, The University of Manchester

Wilson, B., Sherry, L., Dobrovolny, J., Batty, M. and Ryder, M. (2000). "Adoption of learning technologies in schools and universities". Handbook on information technologies for education & training. Adelsberger, H., Collis, B. and Pawlowski, J. New York, Springer-Verlag.

Wilson, B. G. (1995). "Metaphors for Instruction: why we talk about learning environments." Educational Technology 35(5): 25-30. http://carbon.cudenver.edu/~bwilson/metaphor.html accessed 25 April 2004

Wilson, D. C. (1992). "A strategy of change: concepts and controversies in the management of change ". UK, Routledge

Winner, L. (1977). "Autonomous technology: technics-out-of-control as a theme in political thought", MIT Press

Winner, L. (2004). "Technologies as Forms of Life". Readings in the Philosophy of Technology. Kaplan, D. M. Lanham, MD, Rowman and Littlefield: pp103-114.

Wirfs-Brock, R. J. and Schwartz, J. A. (2002). "The Art of Writing Use Cases". OOPSLA 2002: The ACM SIGPLAN Conference on Object-Oriented Programming, Systems, Languages, and Applications, Seattle, USA

Wylde, K., Ellaway, R., Cumming, A. and Cameron, H. (2003). "Electronic submission and delivery of student feedback". AMEE, Bern, Switzerland