

University of Leicester

MBA in Educational Management

Dissertation

**An investigation of the effectiveness of
virtual learning environment
implementation in primary education**

By

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Abstract

Virtual Learning Environments (VLEs), understood here as online systems supporting interactions between and amongst learners and teachers as well as access to resources and activities, have long been held to provide a range of benefits in further and higher education. For 2008, UK Government policy is for all pupils to have access to an online learning space, for many provided through a learning platform such as a VLE. This technology is presently little used in primary education and there are few objective case studies evaluating the appropriateness and effectiveness of VLEs in this context. The author has addressed potential impact of VLEs on school effectiveness through three interrelated areas.

The contribution of VLEs to institutional knowledge management is considered. Knowledge management has received little attention in education, and a small scale, self-selecting sample online survey was used to identify the contribution of VLEs to this area. Responses confirmed little use of knowledge management in schools, and mixed use of VLE tools to codify teachers tacit knowledge; VLEs were however used to share data, information and resources within the school, and supported a culture of collaboration within, and in some cases beyond, the school, such a culture being important for VLE effectiveness in this area. Schools rarely analysed VLE data to support decision making.

The other two areas were addressed through a small scale action research project, introducing the Moodle open source VLE to support the Year 5 and Year 6 mathematics curriculum at the author's school.

Evidence from a review of the relevant literature suggested that VLEs were particularly supportive of social constructivist pedagogy, and the author used a variety of qualitative and quantitative techniques, including the COLLES survey instrument, to identify the

extent to which introducing the VLE had promoted this approach to learning amongst the pilot study cohorts. Within this particular context, there did seem evidence that the VLE had promoted knowledge construction amongst pupils, an awareness of multiple perspectives, stronger sense of ownership and voice, and a greater sense of learning as a social experience. Pupils seemed to be more aware of their development as learners and coped well with multiple modes of representation. They perceived that computer-based activities were more relevant.

By keeping the curriculum and testing regimes unchanged from previous years, the author was able to use a quasi-experimental method to compare progress during the pilot study with that of previous cohorts, factoring out differences in prior attainment. Evidence for improved attainment through the introduction of the VLE was inconclusive, with only a small, statistically insignificant gain. Data mining techniques suggested that pupils using the VLE in a more strategic manner received the greatest benefit.

The author concludes by making a number of recommendations to those seeking to implement VLEs in other schools: including the need to choose a VLE suited to the school's vision and context, consideration of total cost of ownership, developing a collaborative culture within and beyond the school, integration with other information systems, and embedding the system within the school's culture.

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List of abbreviations

Becta	British Educational Communications and Technology Agency
CEM	Curriculum, Evaluation and Management Centre
CIMT	Centre for Innovation in Mathematics Teaching
CLE	Constructivist Learning Environment
COLLES	Constructivist on-line learning environment survey
CTC	City technology college
DfES	Department for Education and Skills
EUN	European Schoolnet
FE	Further education
Ferl	Further Education Resources for Learning
HE	Higher education
HMC	Headmasters' and Headmistresses' Conference
ICT	Information and communication technology
JISC	Joint Information Systems Committee
LA	Local Authority
LCMS	Learning Content Management Systems
MIS	Management information system
MLE	Managed learning environment
OECD	Organisation for Economic Co-operation and Development
OSS	Open source software

P	Probability (used to indicate degree of statistical significance herein)
p2p	Peer to peer
post	Post-test assessment result
pre	Pre-test assessment result
QCA	Qualifications and Curriculum Authority
RBC	Regional Broadband Consortium
SATIPS	Society of Assistant Teachers in Preparatory Schools
SATs	National Curriculum Tests (formerly standard assessment tasks/tests)
SIMS	Schools Information Management System
SMS	Short Message Service (ie mobile phone text message)
SMT	Senior management team
UK	United Kingdom
VLE	Virtual learning environment
VoIP	Voice over Internet Protocol
wiki	Web page system in which pages are editable via a browser

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Introduction

“Buying a VLE is one of the most important decisions for an institution, one that has major implications for it, and should be seen as significant as buying a major new building. The choice of VLE will be significant across all areas of the institution and especially in the way in which teaching and learning are undertaken.” (Minshull 2004, p20, *cf* Becta 2003 p40)

The decision to implement a virtual learning environment (VLE) in a primary aged school presents advantages to, and raises issues for, school management, and is certainly not one that should be taken lightly (Gill & Shaw 2004, *qv* Visscher & Wild 1997, p264, Hargreaves 1999, p123, Visscher *et al* 2003, p364). VLEs appear to offer schools a number of benefits, such as: anytime, anywhere access, improved motivation, access to higher or novel learning styles, opportunities for independent learning, better integration of information and communication technology (ICT) tools, and increased parental engagement (Becta 2004a, *qv* DfES 2005c). There is therefore the potential for “a significant impact on the process of teaching and learning” (*ibid*); indeed Europe wide, national agencies perceive VLEs as:

“Facilitators of changes in education and pedagogy towards more learner centred approaches, enhancing interactivity in learning [and] helping constructional knowledge building” (EUN 2003, p21, *cf* Land & Hannafin 2000, Pentland 2003).

Such an impact would suggest the need for consummate change management skills on behalf of those leading such an implementation (DfES 2005c, Reyes 1997, *qv* Visscher & Bloemen 2001, Davey *et al* 2001 p167). Moreover, management would be failing in its responsibilities if the positive effect such benefits present were neither confirmed empirically (*qv* Carswell *et al* 2000, p29, Oliver & Herrington 2003, p111) nor weighed

against the costs incurred with VLE implementation: financial, in terms of computer hardware, software licensing, initial and ongoing staffing requirements and training (Petre *et al* 1998, p116, Williams 2002, p270, Ash & Bacsich 2002, Becta 2003, p16, p30, Maor 2003, p205, Minshull 2004, p7, *cf* Wild *et al* 2001, p117); potentially negative effects on the morale of staff (Fung & Pun 1997); and issues of equality of access to the curriculum (Williams 2002, p268, Becta 2003, p28).

There is, in what is still a relatively young field, some confusion over the use of terms describing online learning systems (Gill & Shaw 2004, EUN 2003); the UK Further and Higher Education (FE, HE) (JISC) definition seems to have become the most widely accepted:

“A VLE is an electronic system that can provide online interactions of various kinds that can take place between learners and tutors, including online learning” (JISC, 2003a).

In their survey of VLE usage throughout European schools, European Schoolnet adopt a broader definition:

“Any solutions that propose a coherent set of services with pedagogical aims, supporting learning and teaching activities” (EUN 2003, Annex VI, p81).

Becta (2003, p8-9) helpfully provide a list of the different definitions used by commercial developers. Within the UK schools sector, the term ‘learning platform’ has been adopted, with an understanding that this includes, but is not limited to VLE type systems (DfES 2005c, Walker 2006). For the purpose of this study, the JISC definition will be adopted.

Although it is possible to trace the history of VLE style tools back to the earliest days of educational computing (Inglis *et al* 2002 13-14, Winn 2002 p332-335, Ganesan *et al* 2002, p94-95), widespread availability of the technology is quite recent and, it could be argued, much of its present use may be motivated by technological advances rather than

educational needs (Eisienstadt & Vincent 2000, preface p x, Darby 2002, p19-20, Konrad 2003, *qv* Taylor & Maor 2000, Porter 2003, Gill & Shaw 2004, p4, *cf* Ganesan *et al* 2002, p105, Dougiamas & Taylor 2003). VLE usage at present is concentrated in the higher and further education (HE, FE) communities, where it has been taken up with some enthusiasm (Inglis *et al* 2002): for example half of English FE colleges already had a VLE in place by 2001 (Becta 2003). However, “the school sector VLE market is still very immature” (Gill & Shaw 2004, *qv* Becta 2003 p16), although there is a growing interest in the use of VLEs particularly within secondary education, and the DfES are committed to providing all pupils with access to a personal online learning space by 2008 (DfES 2005b), in most cases to be provided via an institutional learning platform.

Given Becta’s (2003) former position that “a fully integrated VLE [may] not be appropriate for a primary school at this stage in VLE development” (p35), and Gill and Shaw’s (2004) perception that primary schools rely “on external inputs to develop their understanding, vision and resultant use of any provided solution” (p3), it is unsurprising that at present there is little evidence of more than isolated use within primary education: in 2003, Becta failed to identify a single UK primary school using a VLE as defined above, (Becta 2003, p34, *cf* Visscher *et al* 1999), although a small number of case studies have emerged more recently (DfES 2005c).

A mere 24 UK schools responded to Schoolnet’s 2002 survey (EUN 2003, p7), and only 10% of all responses were in the elementary sector. In 2003, only 36 independent schools (6% of respondents) reported that curriculum on-line initiatives had any impact, with *no* others indicating that such initiatives, other than virtual language labs, were planned (ISC 2004). However, increasing numbers of schools are exploring this technology, and it seems likely that some of this work will be formally documented. Nevertheless, given the

longer history of VLE usage in HE and FE, almost all academic work on VLE usage has focussed on these sectors.

Thus, for a school about to embark on VLE implementation, there seems much promise of what VLEs may offer and some worries as to the downside of that implementation, but very little *evidence* to support management in their decision to proceed with such an implementation (Gill & Shaw 2004, *qv* Cohen *et al* 2000, p394-5, *cf* Ganesan *et al* 2002, p93). This study seeks to address this want of evidence by investigating the extent to which VLE implementation in a primary aged school can be shown to be effective.

In their analysis of the costs of networked learning, Ash & Bacsich (2002, p29) state “there is a genuine need to develop a methodology to measure effectiveness”, (*qv* Konrad 2003). In this study, effectiveness is considered in three interrelated areas: knowledge management, pupils’ approach to learning, and academic performance, as described in the review of literature below (*qv* EUN 2003, p35, Becta 2003 p32). The areas are interrelated: more effective knowledge management, including an emphasis on the shared construction of knowledge, would affect the approach to learning in a school, which might in turn impact on academic performance, such academic performance data being fed back into a school’s knowledge management procedures. These areas translate into three specific research questions:

Firstly, to what extent does a VLE represent an effective tool for knowledge management within a school, including its use for core management tasks such as planning, accountability, resource management and performance tracking?

Secondly, can VLE implementation be shown to have a positive impact on pupils’ approach to, attitudes about, and perception of their work?

Thirdly, does the implementation of a VLE have any significant impact on pupils’ measurable academic performance?

The author's own school is a small (c. 150 on roll), non-selective independent preparatory school for girls, situated in an affluent part of the South East. An informal survey of parents indicates that almost all have personal computers and Internet connections at home (compared to 49% of UK households with Internet access, (National Statistics 2004)), which are available for their daughters to use: issues of access to online resources and the 'digital divide' are therefore less relevant than they may be elsewhere. Furthermore, the school has a high level of ICT provision with one computer per 3.5 pupils, compared 7.5 pupils in English primary schools (DfES 2004a), and the school's ICT provision was commented on favourably in its most recent inspection report. Such characteristics might facilitate the introduction of a VLE, but also make the difficulties in extrapolating conclusions from a small-scale study more acute.

The author, as deputy head of the school, has become interested in exploring knowledge management within the school's context and this has led to the school's ongoing investigation of school management information systems (MISs) and VLEs. Prior to embarking on the wide ranging change that VLE implementation throughout the school would necessitate (Minshull 2004, p28, Gill & Shaw 2004), it seemed wise for the school to conduct a smaller scale pilot study: to gain expertise in the issues involved in VLE use (allowing the author to take on an 'e-learning champion' type role, as has proven effective in FE implementations (Ferl 2006)), to obtain evidence of VLE effectiveness (*qv* CEM 2004), and to inform subsequent cost-benefit analysis (Davey *et al* 2001, p169). The author therefore conducted a small scale and low cost pilot study of VLE usage within his own teaching of mathematics to Year 5 and 6 classes; pilot implementation being a well established technique in ICT innovation (Darby 2002 p23, EUN 2003, Becta 2003, Konrad 2003, Becta 2004b, Gill & Shaw 2004 appendix, Minshull, 2004). This pilot study

provided the evidence base on which the second and third of the research questions were addressed, as described below.

It was hoped that the pilot would itself be of benefit to those pupils participating in it, but also that the insights gained would enable subsequent full implementation to be accomplished more successfully, with consequent benefits to the school as a whole. Concluding remarks therefore seek to address a fourth research question: what can school management do to ensure the maximum effectiveness of VLE implementation? Since, after all, the “integration of new technology into classroom practice is essentially a problem for management” (Newton, 2003, *qv* Minshull 2004, p5).

Literature Review

Before considering literature relevant to the specific research questions above, it seems appropriate to provide a perspective on literature pertaining to VLEs in general.

VLEs

VLEs are the focus of a rapidly expanding field of academic research, as the number of dedicated journal titles and conferences attest. The field is now sufficiently mature that overviews of the literature have begun to appear, such as those by Winn (2002), Williams (2002), Konrad (2003) and Becta (2003 and 2004a). However, as use within UK schools is still rather limited, little of the literature deals with this area specifically. Those exploring this field at present must use: studies from within HE and FE (*qv* Dillon 1998, p36), where factors such as more flexible patterns of attendance, greater institutional control over curriculum and assessment, typically lower staff teaching commitments, and greater familiarity with flexible learning can apply; software developers case studies, with a potential lack of objectivity and difficulties in generalizing claims made; or studies from overseas, although even in this case there is little work based in schools, and even less in primary schools (Becta 2003). Furthermore, Becta view much of what evidence there is for the benefits of VLEs as anecdotal or inconclusive (*ibid*, p11, 40 *cf* Visscher 2001, p10).

One tension running through much of the literature seems to be between VLEs as a better mechanism for traditional curriculum delivery on the one hand and as facilitators of wide reaching pedagogical change on the other:

“Networked learning can be seen as a progressive site of radical pedagogical experiments, emphasizing the anti-hierarchical structure of the web and the way in which social status differences become invisible in cyberspace, or it can be seen as an instrumentally superior form of knowledge transmission.”

(Fox 2002, p80, *qv* Esienstadt & Vincent 2000, Nolan & Lambert 2001, p82, Becta 2003, p38, EUN 2003, p4, Haughey 2003, Tatnall & Pitman 2003, Barbera 2004, p16).

Attention to both academic performance and approaches to learning in this study maintains this tension. Mäkelä (1997) seems to hold both views, in that he believes information products must

“guide readers through an information space, controlling their exploration along the lines of pre-defined structures” (p28),

yet acknowledges

“students’ responsibility for their own learning and their active role in seeking and using this information” (p29).

Winn (2002) sees this distinction as evolutionary, in that today’s VLEs have grown out of carefully designed instruction and interactive simulations. From a psychological standpoint, earlier computer assisted learning sat well with Piagetian behaviourist perspectives, whereas the utilization of networked communication tools place VLEs more comfortably within a Vygotskian view of the social nature of learning (*ibid*, Dillon 1998, p34). The emphasis on a social constructivist paradigm common to much work on VLEs (see *eg* Jonassen & Land 2000, Konrad 2003, Oliver & Herrington 2003) is further evidence in support of this view. The more traditional emphasis is perhaps clearer within Learning Content Management Systems (LCMS), which provide the “ability to store, assemble and deliver personalised learning content in the form of learning objects” (EUN 2003, p10), and this understanding might perhaps underpin the attention given to personalised content and adaptive learning design apparent in some of Becta’s (2006a) functional requirements for learning platforms.

Despite this tension, there seems broad agreement on what a VLE actually is. Gill and Shaw (2004) expand on the rather broad JISC definition to provide a more useful description of a VLE, perhaps with a just perceptible behaviourist slant:

“A system, in which learners, organised into groups and following online programmes of study, access structured and managed online content, resources and assessments through a web browser. In these systems, teachers have the ability to create and manage resources, collaborate with colleagues and manage the collaboration and communication with and between students. The system tracks usage by learners, progress of learners through courses and automatically marks and records the results of simple tests.” (p1, *qv* Minshull 2004)

Becta (2006a) give a more (perhaps overly) detailed functional specification from an institutional or system wide perspective, grouping requirements into four broad categories of content management, curriculum mapping and planning, learner engagement and administration, and tools and services, although previously (2003, p6) they had simply listed core components as: a bulletin board, course outline, email, conferencing tools, home pages, metadata, assignments, assessments, chat, multimedia resources, file upload, and calendar. Williams (2002, p265) suggests elements that might feature on course websites, adding glossaries to the above list. Schoolnet (EUN 2003, p8) look to the future, and see the evolution of VLEs as integrating the above components with tools for knowledge building, linkage with administrative information and diagnostic tools. Despite this broad agreement, VLE usage in an institution may vary widely, and it is unlikely that all schools will realize the full potential (DfES 2006, EUN 2003 p26, *qv* Jonassen 1999, p219).

Several authors (eg Becta 2003, Minshull 2004, DfES 2005c) provide lists of the potential advantages for institutions and for students that VLE adoption offers. Most of these fit readily within the areas of more effective knowledge management and improved approaches to learning discussed in more detail below, and some can be seen as having the potential to raise pupil attainment, such as the ability to catch up on missed classes (Minshull 2004, p26, DfES 2005c, p11), instant feedback on assessment (Becta 2003, p18) and cross institutional working (DfES 2005c, p10).

One key advantage is the opportunity to provide access to the institution's curriculum from outside its boundaries (DfES 2005c, p8-11, Becta 2003, p14, 15, 19, 28, *qv* Fung & Pun 1997, p18, Smith & Wild 2001, p139, Ganesan *et al* 2002): either for pupils completing homework; those not able to attend school; those attending other institutions (as Thomas Telford CTC has done, see www.ttsonline.net/general/projects/ttscourses.html); or, particularly in the case of HE, distance learning students. This can be seen as an aspect of knowledge management, as the institutions involved have identified a new way of exploiting their shared intellectual capital (*qv* Sallis & Jones 2002, p90-92, Porter 2003, p381). Furthermore, staff access to the VLE from home provides opportunities for more flexible working arrangements (Haughey 2003)

The European Schoolnet survey (EUN 2003) provides some empirical evidence on actual usage of VLEs in European schools. However, as VLE usage is a fast developing field and this survey relied on volunteer responses, its conclusions should not be regarded as entirely reliable or representative (Cohen 2000, p102), nevertheless some points seem of particular interest for this study. The survey found that two-thirds of respondents were using VLEs with their own classes, perhaps as early adopters in pilot studies, but a quarter of these teachers were also using VLEs to support teaching outside their own school, often in the form of international school collaboration. Teachers seemed

comfortable using the VLE in a conventional classroom setting but were less willing to explore its full potential. Schoolnet suggested that this might be due to the HE focused development of the then generation of VLEs (EUN 2003, p35). For mathematics teaching, the curriculum area in the pilot study, VLEs were used regularly by 31% of respondents and at least “sometimes” by 78% (*ibid*, p18).

Despite worries about ‘the digital divide’ (Smith & Wild 2001, p159, Sallis & Jones 2002, Valentine et al 2005) and concerns over equality of access to an online curriculum (Becta 2003, p28, Williams 2002 p268), VLEs can *enable* greater access to the curriculum, through specific technological innovation (Vincent & Whalley 1998, DfES 2005c *qv* Konrad 2003), but also simply as computer mediated communication can make it easier for shy or quiet students to join in (Rimmershaw 1999, p199, Williams 2002, p266).

VLEs are commonly used to provide a meta-environment, integrating a rich mix of online resources (Sumner & Taylor 1998, Jonassen 1999, p225, *qv* Montieth & Smith 2001). This is a common way for online courses to be created (Minshull 2004, p25) and gives the teacher the role of ‘knowledge broker’ (Fung & Pun 1997, Davenport & Prusak 2000, p29-30), which is important due to the enormous amount and varying quality of information available to the learner (Kayama & Okamoto 2002, p250), and because “The process of seeking information may distract learners from their primary goal of problem solving” (Jonassen 1999, p228, *qv* Kirschner *et al* 2006).

There is a need to “ensure that students learning experiences are improved rather than simply replaced or confused” (Williams 2002, p264), rather than merely publishing overhead slides, text book extracts and exercises online (Esienstadt and Vincent 2000, Darby 2002, Oliver & Herrington 2003): Petre *et al* (1998) argue that success is dependent on cultural change for both student and tutor, whilst acknowledging that good teaching is indispensable (*qv* Mäkelä 1997). However, Spector warns that:

“The role of teaching in technology intensive settings is more difficult and more crucial than ever before. Only a rare few master the skills required to effectively integrate technology into learning and instruction, and teachers themselves admit this.” (2002, p *xiv*).

The implied redesign of courses (Oliver & Herrington 2003) can “be a positive experience, providing a chance to review the curriculum and reassess learning outcomes” (Williams 2002, p264), with clear potential for organizational learning. From a knowledge management perspective, there are clear benefits to digitising course content which previously might have existed “only in the heads of tutors” (*op cit*), or in their private planning. Moreover, digitisation enables learners to become “active in seeking information and constructing their own learning experience, rather than being ‘passive receptors of knowledge’” (*op cit*).

However, as Minshull (2004) reports, there is

“Considerable dissatisfaction within some areas of the school educational community in what is currently being offered as a VLE solution.” (p15, *qv* Gill & Shaw 2004, p4, EUN 2003, p34, *cf* Fulmer & Frank 1997, p128, Leidner 2003, p498, Porter 2003 p 380, Lobry de Bruyn 2004, p67)

It is possible that the dissatisfaction is due to the lack of involvement of teachers in the development of the commercial products used, which may have resulted in a poor fit to schools’ pedagogic requirements:

“Most of the current generation of VLEs are not designed to support learning changes but to deliver distance-learning courses to university students” (EUN 2003, p35, *cf* Fung & Visscher 2001, p82, Tatnall & Davey 2001, p63, Wild *et al* 2001, p118)

With this in view, it seems odd that Becta's (2006a) list of functional requirements has been drafted with relatively little consultation with schools, teachers or learners.

Knowledge Management

“In the information society, knowledge forms the foundation for education and culture” (Smith & Wild 2001, p152)

The field of knowledge management is of great importance in industry and business generally, in part because technological economies are increasingly knowledge based (Sallis & Jones 2002 p xii, *qv* OECD 2000 p67), but also through a growing realization that intellectual capital is the key driver in organizational success (Osorio *et al* 2001, p41-42, Sallis & Jones 2002, p1). There is also a realization that an organization's people are the locus of much of its knowledge, and the field has matured alongside advances in technological potential.

In education, it has received little attention (OECD 2000, p70, Sallis & Jones 2002 p xiv, Thorn 2003, p22, Kirkup *et al* 2005), although there are notable exception such as Hargreaves (1998, 1999), OECD (2000) and Sallis & Jones (2002). Whilst it is not unusual for techniques of management in education to lag behind those in the wider world (Smith & Wild 2001, p140, *cf* OECD 2000, p70), this seems surprising in this case, as education is surely all about transmitting and/or cultivating knowledge (OECD 2000, p70, Sallis & Jones 2002 p xiv). The following review of relevant literature focuses on those aspects of knowledge management in schools that might be best facilitated through use of a VLE, and thus also draws on research into school management information systems.

Quintas (2002) observes that

“For the majority of firms in the west, the priorities are the ‘capture’ of employees’ knowledge, exploitation of existing knowledge resources or assets, and improved access to expertise.” (p9)

One key difficulty for those seeking to do this in education is the high proportion of a teacher’s knowledge that is tacit rather than explicit. (Fulmer & Frank 1997, p126, Hargreaves 1999, p138, OECD 2000, p71), and thus the challenge seems to be to find a way to externalise or codify the pedagogic insights which are “locked in the heads of individual teachers and protected by the privacy of their classrooms” (Hargreaves, 1999, p124, *qv* Goodyear 2002, p64). Whilst some of this knowledge will undoubtedly remain tacit, VLEs have the potential to make much that pertains to this knowledge, such as lesson planning (Becta 2003, p35, Konrad 2003, Haughey 2003, p67), online resources (Becta 2003, p29, EUN 2003), assessment data (Haughey 2003), and even pupil-teacher discussions (*qv* Lobry de Bruyn 2004) explicit and capable of codification, and thus readily accessible storage. Moreover, such a knowledge mapping (Davenport & Prusak 2000, p72-80) naturally codifies the teachers’ knowledge into the categories which are meaningful for others’ professional practice (Hargreaves 1999, p125), and, through such a digital representation, it becomes easier

“To talk concretely about what we know; to diagnose weaknesses in what we know; [and] to improve ways of knowing.” (Eisenstadt & Vincent, 1998, p15)

Through computer networks (Osorio *et al* 2001, p36, Pentland 2003, p529), these aspects of teachers’ working knowledge can be readily shared throughout the organization. Sharing information, which is not uncommon in primary schools (Nolan & Lambert 2001, p72), seems key to organizational success in a knowledge based society (Reyes 1997, p76, *qv* Pentland 2003, p547) and makes possible the shared decision making on

which a school's growth as a learning organization depends (Nolan & Lambert 2001, p83, *qv* Reyes 1997, p74, Brown & Duguid 2002, p25, Quintas 2002, p10).

This sharing can extend beyond the organization's boundaries and, while the Schoolnet survey (EUN 2003) suggested that VLE usage was perceived principally as a tool for teachers to organize their own work, it also indicated a high level of usage of communication tools for professional collaboration (*qv* OECD 2000, p77, *cf* p98). Furthermore, VLEs allow teachers to create content and share it with educators around the world (Becta 2003, p37, *qv* Berry & Partridge 2006), to work collaboratively on instructional design (Ganesan *et al* 2002), and, by drawing together resources from outside an organization, make it easier for schools to absorb knowledge created elsewhere (Quintas 2002, p7). Transfer and reusability of content is therefore important if VLEs are to become effective knowledge management tools (Becta 2003, EUN 2003, DfES 2005a). Such reusability depends upon the development of interoperability standards, which is now a priority for national agencies throughout Europe (*ibid*, DfES 2004b): the Schoolnet paper provides an overview of some of the relevant standards (EUN 2003, p30) and Becta (2006b) have specified a number of these for English schools, although Konrad (2003) warns that specification may reflect "market power rather than educational needs".

Making teacher's working knowledge readily accessible in this way and then allowing others to adapt it to their own context facilitates true knowledge transfer (Hargreaves, 1999 p131-2, *cf* OECD 2000, p75), and provides a mechanism for validating knowledge by turning it "into practice which demonstrably and repeatedly works" (Hargreaves 1999, p128).

The wealth of data and information which a fully populated VLE would contain would allow new knowledge, in the form of trends, patterns and exceptions in student data, to

be isolated through techniques such as data mining (Wild *et al* 2001, *cf* Brown & Duguid 2002, p27); although it is important to avoid information overload (Visscher & Branderhorst 2001, p148, p152). Such techniques could facilitate better-informed decision making for management (*ibid*), customer relationship management, and pupil support (Visscher & Wild 1997, p271, Kirkup *et al* 2005).

Such claims were made for school management information systems, which have long had a place within the information infrastructure of schools, but have had relatively little impact on actual classroom practice (Visscher & Wild 1997, Fulmer & Frank 1997). This is perhaps because they do not capture the knowledge or information that teachers and managers actually use in their daily lives, (Quintas 2002, p8, *qv* Witziers 1999, p113, Visscher 2001, p9), or because they were designed to meet accountability demands (Nolan & Lambert 2001, p79, Thorn 2003). A VLE, however, is designed to manage the knowledge that is at the core of the school's activity, *ie* teaching and learning. This is an important distinction, as

“Information systems can affect the critical process of knowledge construction and organization by changing the epistemic criteria used in knowledge construction and by changing the content of the material that emerges from the creation process.” (Pentland 2003, p534, *qv* p526)

A VLE is also more accommodating “of the inherent complexity, sophistication and subtlety of professional life and work in educational institutions” (Nolan & Lambert 2001, p83) and facilitates analysis of qualitative data (*ibid*, p79, p83).

Interoperability, and perhaps ultimately integration (Smith & Wild 2001), with MIS software would seem to be important in ensuring the greatest benefit of VLEs from a knowledge management perspective (Visscher 2001, p15) and greater relevance of MIS to classroom practice. The term managed learning environment (MLE) is used for

systems in which VLE, MIS and communication functions are fully integrated (Becta 2003), although as yet no significant level of integration has been achieved (Gill & Shaw 2004 p4, *cf* Bruno 1995, Visscher & Wild 1997). New products such as Phoenix E1 (<http://www.pearsonphoenix.com/products/product.php?id=68>) and SIMS .net Learning Platform (<http://home.capitaes.co.uk/sims/sims.asp>) indicate that the commercial software houses are beginning to explore these issues, as Smith & Wild (2001) had anticipated, and Becta (2005b) are keen to ensure interoperability between such systems. Whether such offerings will represent 'best of breed' VLEs remains to be seen (Gill & Shaw 2004, p5), especially as Fulmer & Frank (1997, p124) argue that the lack of attention paid to teaching and learning in most MIS has been a direct result of their construction outside the organizations that were to use them. Experience in the MIS field suggests that such integration may result in teachers and schools having to adapt their own practice to suit the system (Visscher 2001, p15, *cf*, p74), with a consequent tightening of control between education authorities and schools, and between principals and teachers (Tatnall & Pitman 2003, p81); the extent to which schools can be said to 'own' the data in their MIS may also be limited (Becta 2005b).

There may be further potential for VLEs to support knowledge creation and organizational learning (OECD 2002, p79). Hargreaves (1999, p141) sees knowledge creation as rooted in interactive learning and believes that factors, which a VLE might promote, such as placing value on task related expertise among staff rather than organizational status and a willingness to tinker and experiment with new ideas in an ad-hoc way are likely to foster it (*ibid*, p126). Furthermore, the social constructivist paradigms prevalent within VLE work apply to teachers as well as learners: the OECD asserts the need for a move from working and learning alone to a model in which "the co-production of knowledge with colleagues [is] a natural part of a teacher's professional

work” (OECD 2000, p74, *qv* DfES 2005a p31-33), and staff use of VLE tools provides for such activities. Nor should knowledge creation in schools be limited to the teaching staff – pupils using VLE tools to author content are themselves creating knowledge artefacts (Esiensstadt & Vincent 2000, p xii). Indeed, the content of online discussion threads forms an important reusable resource of problems and solutions (Kawachi 2003 p76, *qv* Okamoto & Inaba 1997, Lobry de Bruyn 2004, p68-69.).

One further area, which might fit under the umbrella of knowledge management, is accountability (Sallis & Jones 2002, p xv, *qv* Smith & Wild 2001, p140). The sharing of working practice described above would do much to establish a mechanism for accountability between teachers and their pupils, amongst colleagues and, of course, to management, without being beset by the dangers of an accountability led system of which Thorn (2003) warns.

From the evidence above it seems clear that, correctly implemented, a VLE can provide much of the

“Infrastructure to support knowledge management in education [that] will be needed... [without which] schools, colleges and universities cannot truly become the learning organizations that are essential to ‘schooling for tomorrow’” (OECD 2000, p88).

Thus, the first goal of this study is to ascertain the extent to which VLEs are providing this support for knowledge management within schools.

Approaches to learning

VLEs, perhaps in common with educational innovation generally, come with particular views of education attached to them (Becta 2003, p11), this has typically been a social constructivist paradigm (Jonassen & Land 2000, Taylor & Maor, 2000, Hughes & Daykin 2002, Dougiamas & Taylor 2002, p2, Konrad 2003, Oliver & Herrington 2003). There are

several reasons for this: social constructivists have come to realize that VLEs powerfully leverage ICT towards such aims (Land & Hannafin 2000, p16, *qv* Giodorno 1996, p360, Hammond 1999, p353, Becta 2003 p18, 23); VLE advocates find within social constructivism a theoretical basis to underpin their work (Maor 2003, p215, *qv* Jones and Steeples 2002, p4); and there is

“A growing consensus around 'good learning', perhaps best summarized by thinking of learning as a guided process of knowledge-construction.”

(Goodyear 2002, p59, *qv* Jonassen & Land 2000, p viii).

Although such a consensus is by no means universally adopted (eg Kirschner 2006), and this approach has received little attention in Becta (2006a) and DfES publications (2005b, 2005c, cf 2005a). Similarly, the Schoolnet survey (EUN 2003) found little evidence that in practice VLEs had been used “to support learners’ knowledge building and acquisition of new cognitive skills” (p26, *cf* Hughes & Daykin 2002), suggesting a need for further research to establish the extent to which practical use of a VLE results in social constructivist type changes in pupils’ approaches, attitudes and perceptions. This forms the second focus of this study.

If VLEs are likely to promote or require changes in learning style, then a change in teaching style will also be involved (Williams 2002, p269, Maor 2003, p202), moving towards a more learner centred model (Smith & Wild 2001, p138, EUN 2003, p26), with the teacher’s role changing from “sage on the stage to guide on the side” (Minshull 2004, p5, *qv* Taylor & Maor 2000). A priority for teachers becomes equipping their pupils to learn for themselves (Mäkelä 1997, Ringsted 1998, p280, Gibbs 1999, p230, Williams 2002, p265, OECD 2000, p73-74, *qv* Visscher & Wild 1997). Particular teaching strategies such as coaching and scaffolding seem well suited to this end (Jonassen 1999, p232-236, Oliver & Herrington 2003, p116). Maor (2003, p214) found that teachers’

affective support was a critical motivating factor for students, and teachers' expertise in content and pedagogy remain important (Ringsted 1998, p280), within the context of learning task and environment design (Goodyear 2002, p66). Visscher & Wild (1997) warn that prevailing classroom culture determines whether such changes in teaching style are seen positively or negatively, and Goodyear (2002) reminds us that there is a

“legitimate gap between the activities we set for learners... and the activities in which they actually engage” (Goodyear 2002, p50, *qv* p57)

There seems a broad consensus within the literature studied as to effective approaches to learning: Maor (2002, p203) looks for participation, reflective thinking and collaboration; Jonassen (1999, p223) emphasizes active involvement and effort; Montieith & Smith (2001, p122) add intrinsic motivation and a well-structured knowledge base as conditions for promoting 'deep learning'; Goodyear (2002, p59), with a more individual focus, includes self regulation and goal orientation; and Oliver & Herrington (2003, p115) explicitly include problem solving. These are compatible with, but not limited to, a social constructivist paradigm.

One framework for analysing the effective approaches to learning that a VLE might promote is Cunningham *et al's* (1993) seven goals of constructivist learning environments. Such environments should:

“Provide experience in the **knowledge construction** process; provide experience in and appreciation for, **multiple perspectives**; embed learning in **realistic and relevant contexts**; encourage **ownership** and **voice** in the learning process; embed learning in **social experience**; encourage the use of multiple **modes of representation**; [and] encourage **self-awareness** in the knowledge construction process” (cited in Oliver & Herington 2003, p113, emphasis added).

This framework is used to structure the discussion of the relevant literature that follows. Jonassen (1999, p231) believes that requiring learners to articulate what they are doing and to explain the strategies they use supports **knowledge construction**, and Goodyear (2002, p61) observes that there are learning gains on *both* sides when one person explains something to another. Gibbs (1999) confirmed that, in her use of VLEs to support a HE philosophy course, students writing for discussion forums clarified their thinking, engaging these students in a process of actively constructing meaning (Land & Hannafin 2000, p12). Hammond's (1999) students found that their writing had become more fluent and coherent and valued the reflection which writing for on line discussions promoted, despite finding it time consuming.

Gibbs (1999, p225, 228) found that her students had learnt from seeing the **multiple perspectives** of others' contributions to forum discussions (*qv* Hughes & Daykin 2002, p222), and Dougiamas & Taylor (2003) have encouraged students to engage as 'connected knowers', who are seen as better at learning cooperatively, are more congenial and more willing to build on others' ideas. Perspectives can be extended to include those from other countries (Ringsted 1998, p280). Hammond's study (1999), however, encountered problems of under participation in forums, which thus limited the extent to which participants could appreciate alternative perspectives, although, perhaps not surprisingly, he found that "Peer assessment seemed to generate debate" (Hammond 1999, p357), in contrast to Hughes & Daykin's (2002, p220) observation that students seemed reluctant to criticize other people's work. Maor (2003) also found that

"Some learners participated more actively than others, making the quality and depth of the discourse uneven, and contributing to tensions arising within the group" (p 206).

Lobry de Bruyn (2004) advocates “explicit linking of online discussions to student outcomes and learning objectives” (p78) as a way improving the quality and quantity of student participation.

Jonassen (1999, p219-221) strongly advocates case- or problem- based approaches anchored in meaningful, **realistic contexts** in which appealing problem presentation engages learners in “the same type of cognitive challenges as those in the real world” (*ibid* p221, cf Kirschner et al 2006). By making readily accessible resources from real-world websites, VLEs can directly relate learning to context and practice (Oliver & Herrington 2003, p113, *qv* p115)

The learner’s sense of autonomy (Oliver & Herrington 2003, p113) or **ownership** is enhanced in a well-constructed VLE, as the learner

“Determines how to proceed based on individual needs, ... [is] given opportunities to make choices and pursue individual interest, ... [and] evolve[s] greater responsibility for their own learning” (Land & Hannafin 2000, p12, *qv* Montieth & Smith 2001, p122).

Such choices can range from deciding which online resources are most suitable for a particular learning goal (Oliver & Herrington 2003, p117), to deciding for themselves what their own learning goals or strategies are (Gibbs 1999, p230, Hammond 1999, p360). Curiously, Becta (2003, p20) see such taking of responsibility as a benefit specific to able pupils, and such self-determination is provided for within their list of functional requirements (2006a). Montieth & Smith (2001, p122, *qv* Kirschner *et al* 2006) warn of the superficiality of some independent working, as what learners do and learn often remains tutor directed.

One of Maor’s (2003) students appreciated the sense of **voice** that use of a VLE had promoted:

“No longer were my work, responses and ideas directed to and read only by my lecturer, but they became open to comments, feedback and discussions from other students” (quoted in Maor 2003, p212).

Through use of the Internet, “Children have become authors in the knowledge society rather than merely recipients of information” (Eisenstadt & Vincent 2000, p xii). Rimmershaw (1999, p195) found that emphasis on students’ contributions had given them confidence in their own learning and Hammond’s (1999) participants appreciated the advantage of not being interrupted, and some seemed especially willing to support or mentor others, although there was some anxiety “about leaving a permanent record of a contribution” (*ibid*, p357).

It is perhaps in the area of the **social experience** of learning that VLEs are of most obvious benefit. Their communication tools, which must be “an integral part of creating an interactive learning environment” (Lobry de Bruyn 2004, p68), facilitate collaborative learning, requiring students to be both active and interactive, and encourage a more dynamic engagement in the learning process (Williams 2002, p266). Furthermore, in a school context, home or holiday work can now also be based on “interaction, group work, and the exchange of ideas” (*op cit*), and such tools are of immediate benefit to distance learning students (Carswell *et al* 2000). Jonassen (1999, p221, 228) stresses the importance of collaborative learning and indicates the potential of technology to provide the appropriate tools. Rimmershaw (1999) reports positively on the value of such tools by making collaborative learning more visible and accepted, thus promoting a more supportive study culture, although Hughes & Daykin’s (2002) students’ communications were mainly limited to those between themselves and their tutor. Maor’s (2003) work, by developing the “responsibility of the individual not only for his/her own learning but also that of other students” (p206, *cf* Oliver & Herrington 2003, p116) went further still,

emphasizing the importance of the community, “where interaction and communication took precedence over individual learning” (Maor 2003, p201). There is a clear link with knowledge management here, where the importance of individual knowledge is down played, “in favour of an explicitly social conception of knowledge” (Pentland 2003, p546 *cf* Jonassen & Land 2000, p vi).

In so far as VLEs are tools for bringing together a wide variety of online resources (Jonassen 1999, p225, Hammond 1999, p353, Montieth & Smith 2001), they make their users aware of **multiple modes of representation** and students learn to “navigate through and evaluate a variety of potentially relevant resources” (Land & Hannafin 2000, p17, *qv* Oliver & Herrington 2003, p117). Furthermore, VLEs allow students to upload their own computer-based work and make this available as a resource on which their peers may draw, clearly of importance in a social constructivist pedagogy.

Goodyear (2002, p59) stresses the importance of both the learner’s **self-awareness** of their activity and the ability to take action based on that reflection as characteristic of effective learning, similarly Jonassen (1999) emphasizes the importance of “mindful activity” (p222, *cf* Oliver & Herrington 2003, p113). Goodyear (2002) maintains that

“Effective learning is characterized by both (a) the learner's awareness of their own learning activity... and (b) the learner's ability to take action based on this reflection” (p59)

VLEs can support such reflection through a number of tools, such as conferencing (Jonassen 1999, p230, *qv* Kawachi 2003, p61); online assessment tools which “encourage the strategic exploration of errors” (Oliver & Herrington 2003, p113); and targeted journaling activities.

As might be expected from the above, the use of VLEs should have a positive effect on learners' motivation (Gibbs 1999, p230, Williams 2002, p271, EUN 2003, p20, Gill & Shaw 2004, p3, *qv* Kawachi 2003), even if it may involve them in extra work (Rimmershaw 1999, p200). Schoolnet reported the inspirational effect of VLE use on both teachers and learners (EUN 2003, p28) and Hammond (1999, p366) reported positively on learners' willingness to try things out for themselves. Those contemplating adopting such technology might be reassured by Gibbs' (1999) observation that:

“The whole environment was taken seriously by students. There was no evidence of misuse or abuse in the system” (p229),

although her philosophy students may not be representative of learners elsewhere.

One factor affecting learner motivation, either positively or negatively, is the electronically mediated nature of VLEs, and several authors warn of problems associated with using ICT as the medium for education. Hammond (1999, p365) believes there is a significant technical threshold, which might hinder participation; Goodyear (2002, p60) remarks that technical frustration can result in a negative effect on performance and motivation; and Konrad (2003) lists twelve learner characteristics needed for success in online courses, whilst observing that, for his own students (aged 18-20):

“Their level of competence and confidence in using ICT applications is often too low to enable engagement with a VLE.”

Hughes & Daykin (2002), however, found that their nursing management students quickly overcame anxieties about online learning, whereas Becta (2003) question whether less able students will have “the self-discipline and concentration that individualized online learning requires” (p19).

More positively, good use of ICT could remove the need to perform repetitive, algorithmic tasks, freeing up cognitive resources for “more intensive, higher order cognitive tasks

that need to be performed” (Jonassen 1999, p228, *cf* Kirschner *et al* 2006). Carswell *et al*'s (2000) use of a VLE for distance learning increased interaction between student and tutor, and perhaps not surprisingly, these students “felt that they had gained valuable experience in using the Internet” (p 44), and Montieth & Smith's (2001) students “believed that easy access to information through the Internet did indeed facilitate their learning.” (p122)

Attainment

It therefore would seem that use of a VLE should improve pupils' approaches to learning, perhaps particularly within a social constructivist approach to education. Thus it is surprising that little of the research reviewed for this study provided evidence of *measurable* gains in learners' actual attainment brought about by VLE implementation (*qv* Barbera 2004, p14), indeed Becta (2003) actually warn that “It is unhelpful to compare VLEs with traditional ways of learning as this misses the point” (p12).

This lack of evidence may be due to a realization of the difficulties inherent in assessing learners' attainment: Gibbs (1999, p221) observed that students were capable of passing modules without achieving a deeper, conceptual understanding, perhaps due to what Kawachi (2003, p60) characterizes as the ‘carrot and stick’ focus on extrinsic motivation; Dillon (1998, p37) noted the distinction between learning reported by students and that observed by tutors; and few would disagree with Carswell *et al* (2000, p30), that student experience, intellectual self-development and self-awareness are more important than student performance *per se*. However, the assessment of performance undoubtedly affects the experience of learning (see *eg* Gibbs 1999, p226, Rimmershaw 1999, p197), and the Schoolnet conclusion that the assessment methodologies used by schools in VLEs reinforced “old pedagogies and cultures” (EUN 2003, p34), suggests that present schools assessment priorities may limit the effects of VLEs (Land & Hannafin 2000, p2).

In HE, where there is considerably more institutional autonomy over the form of assessment, a social constructivist approach to learning can be accompanied by changes in the form of assessment to remove inconsistencies between teaching methods and assessment procedures (Goodyear 2002, p57). Spector (2002, p xv, *qv* Jonassen 1999, p229), for instance, highlights the need to introduce new forms of assessment as the focus moves to the learning community rather than the individual learner.

There is also potential for VLEs to provide alternative modes of assessment, for example: Rimmershaw (1999) used material from students' on-line conference submissions as the basis of the final exam, the form of which was decided by the students' themselves; Oliver & Herrington (2003, p115) see assessment as integrated with the learning activity in task-, problem- or case- based learning; and Jonassen (1999) recommends that:

“Most forms of testing in CLEs [Constructivist Learning Environments] should be automated so that learners can simply call for test results” (p228).

It seems likely that other ways of “capturing learning paths and the processes learners go through” (EUN 2003, p34) will arise as VLEs continue to develop (*op cit*).

Despite the above concerns over assessment of attainment, there do seem to be several ways in which the use of a VLE would directly promote learner attainment (Becta 2003, p36), such as: immediate feedback; extra support outside traditional hours; enabling pupils who have missed lessons to catch up (*ibid*, p35-36); and opportunities for students to revise cooperatively prior to exams (Kawachi 2003, p68). Information within the VLE on pupils' progress could facilitate the interactive management of learning so that tasks can be tailored more closely to individuals' needs (Visscher & Wild 1997, p272, *qv* DfES 2005a), which may well lead to significant academic gains (Smith & Wild 2001, p151).

There is though very limited evidence to support these claims. Some of the Schoolnet survey respondents did confirm that:

“The use of a VLE combined with a more ‘active’ pedagogical approach, the possibility to collaborate, and given independence to learners, helped to deliver expected pedagogical outcomes and made a difference in learners achievement” (EUN 2003, p20).

In HE, Gibbs (1999) found a slight improvement in learners’ marks through use of a VLE, but the improvement was not statistically significant, whereas Carswell *et al* (2000) found no significant difference in assignment or exam performance between Internet and traditional distance learning modes for module delivery, such an experience is not uncommon, with Russell (1999) listing 355 studies with similar findings. Fuchs and Wößmann (2004) reported *negative* correlation between home computer use and PISA test results once school characteristics and family background had been factored out, although their study did suggest a positive relationship for educational and communication use at home, and Kirschner *et al* (2006) cite studies in which constructivist approaches are shown to lack measurable effectiveness.

In schools, there is perhaps a greater exam focus than in HE, with more prevalent use of standardized or nationwide testing, and so, despite the above concerns on the problems of assessment in the social constructivist paradigm prevalent in VLE usage, as VLEs become more common in this sector, there will be more studies using exam data to measure the effect of VLE usage, which forms the third area of investigation in this study.

Methodology

Knowledge Management

In order to build up a picture of the contributions VLEs can make to effective knowledge management in schools, it was necessary to obtain data from schools already using them. The limited use of such technology in schools suggested a questionnaire based survey, rather than a series of interviews, be used in order to maximize the number of potential responses and thus provide the widest picture of VLE use for knowledge management, particularly given the limited resources available for this project, (Johnson 1994, p42-43). Due to the subject matter and in order to encourage easier response and facilitate more efficient data collection (*cf* Cohen *et al* 2000, p264-5), it seemed appropriate to use a web-based rather than postal, telephone, or email survey (*cf* Johnson 1994, p40-41).

As VLE usage in schools has been very limited, construction of a representative sample is problematic, since a random sample of say 100 schools might only include a handful actually using VLEs, and whilst such an approach would be useful in establishing the extent of VLE usage, this study is concerned with effectiveness in practice (*qv* Fogelman 2002, p95). Nor is the author aware of any comprehensive list of schools using VLEs from which a probability sample (*cf* Blalock 1970, Fogelman 2002 p99), or indeed census, might have been taken.

The sampling approach therefore had to rely on voluntary contributions from existing VLE users, as was the case with Schoolnet's survey (EUN 2003), thus making it difficult to draw representative conclusions. However, unlike the Schoolnet survey, where the invitation to participate was limited to a number of Schoolnet information channels (*ibid* p7), an attempt was made to encourage response from a wide range of VLE users by inviting commercial and open source VLE providers and the regional broadband consortia to make the website address of the survey available to the schools using their

products or services. Responses were also invited from members of online communities in which the author participates, such as the SATIPS (Society of Assistant Teachers in Preparatory Schools) and HMC (Headmasters' and Headmistresses' Conference) ICT discussion lists and Becta's ICT Research Network, who were asked to pilot the survey before wider distribution (Johnson 1994, p39-40). The survey was made available for a six week period in the second half of the 2005 Spring term, providing a 'snapshot' of school VLE usage at that time. This sampling technique might best be described as a combination of purposive and 'snowball' sampling (Cohen *et al* 2000, p103-4, Fogelman 2002, p101-3). Responses were invited from UK schools only, but both primary and secondary phase schools were included, nor were additional responses from other phases or countries rejected as they could provide useful comparative data. The survey was constructed to allow a number of different types of users to complete it, rather than limiting it to those with knowledge of VLEs from a senior management perspective, again so as to maximize response and provide a broader perspective. As the survey was publicly accessible on the Web, a random sample of responses were validated with the originating institution to provide some indication of authenticity.

The survey itself (see appendix 1) had much in common with Visscher *et al*'s survey of MIS use (2003), which analysed both module use and users' perceptions of its benefits. It consisted of four main sections. The first requested confidential background data on the institution, the individual completing the questionnaire and the particular VLE used. These questions are largely taken from the Schoolnet survey (EUN 2003), to allow triangulation with this earlier, larger scale project. The second section asked respondents to identify the tools within the VLE that they used and the extent of that use, using a three point Likert scale ('never', 'occasionally', and 'frequently', *qv* Cohen *et al* 2000, p252-3), with additional responses for "facility not present" and "don't know";

the list of tools being a modified version of that given in the Schoolnet survey (EUN 2003), again to facilitate comparison. The third section presents a number of statements concerning the use of the VLE to promote aspects of knowledge management, arising out of the literature review above, and asks for a response on a standard five point 'strongly disagree' to 'strongly agree' Likert scale (Cohen *et al* 2000, 252-3), facilitating subsequent analysis; respondents were additionally able to add further comments. The fourth section asked whether VLE use had promoted improvements in approaches to learning and pupil attainment, in order to provide some data for triangulation of the pilot study data (Johnson 1994, p8-9, Bush 2002 p68-70). Respondents were finally asked to indicate whether they would be willing to take part in further research, although no such follow-up is at present planned (*qv* Johnson 1994, p43).

Data analysis was principally through a number of quantitative techniques, and multi-dimensional analysis of responses (Cohen *et al* 2000, p349-369) revealed factors, such as the use of particular VLE tools, which may be of significance in using VLEs for effective knowledge management.

The Pilot Study

The other two research questions, on approaches to learning and pupil attainment were addressed through a small scale pilot study of VLE use within the author's own institution over the 2004-2005 academic year.

Due to the lack of research on VLE implementation in schools, there was no body of 'best practice' that would normally inform the construction of an experimental pilot study as was envisaged here. The approach therefore must be more akin to participatory action research (Coleman & Lumby 1999, Cohen *et al* 2000, p226-241, Lomax 2002) in which aspects of good practice are developed and refined through active and reflective

involvement in the ongoing evolution of the VLE, rather than a more scientifically rigorous experiment based approach. Winn (2002, *qv* Davey *et al* 2001) highlights the importance of design experiments in the development and study of learning environments, in which the environment is revised iteratively through the course of studying it, with frequent evaluations in real settings, with real students and teachers, which immediately addresses the not uncommon problem of connecting educational research with school practice (Coleman & Lumby 1999). A trial and improvement approach within this field is confirmed by Williams' (2002) review of the literature and sits comfortably with Hargreaves (1999) views on knowledge management in education:

“In knowledge creating schools, the teachers take particular advantage of ... the readiness of teachers to ‘tinker’, and elaborate and extend it in the interests of collective knowledge creation” (p130, *qv* OECD 2000, p72),

in stark contrast to Johnson's dismissal of action research as

“interventionist tinkering ... [which] does not equate with my view of research” (Johnson 1994, p35).

The need for informed involvement in the development of the VLE and the deliberately small scale nature of the pilot suggested the author's own teaching sets (17 Year 5 pupils and two ability based sets of Year 6 pupils, of 12 and 15 pupils; these latter being prepared for entrance exams to senior schools in early January 2005), as the best groups for the pilot study (*qv* Cohen *et al* 2000, p229), although this necessarily restricted the subject taught to mathematics. Constructivism has a substantial following within the mathematics education community (see, *eg*, Ernest 1994, Jaworski 1994) and, for historical reasons, there have been close links between mathematics and computing (see, *eg*, Tinsley & Johnson 1998, Way & Beardson 2003). The use of the author's own teaching groups might be seen as problematic, although there are precedents for this (Gibbs,

1999, Rimmershaw 1999, Dougiamas & Taylor 2003, Maor 2003, McPherson & Baptista Nunes 2004), and this facilitated a more detailed knowledge of the participants in the study; development of content alongside implementation; minimum disruption to the working life of the school; a degree of trust amongst participants and their parents; and future direct SMT experience in VLE usage, which would be important for future change management issues. (Becta 2003, p31, Minshull 2004, p7, DfES 2005c, p17). The author was conscious of the dangers of reduced objectivity which participant research can imply and strove to maintain the detachment necessary for academic research. Despite the small scale of the pilot, use of these classes represents the involvement of one third of the school's roll, for a subject allocated 5 hours out of a 27.5 hour timetable and notionally 50 minutes out of an allocated 200 minutes homework, giving the study significance, even if not representativeness, within the school's curriculum. This restricted approach still provided useful data, and has provided sufficient evidence to justify wider scale use of the VLE within the author's school, despite Reyes (1997) warning that "Schools cannot immediately gauge the success of their actions or strategies" (p75).

It is impossible to remove or isolate the influence of other factors in a study of this sort (Winn 2002, *qv* Johnson 1994, p29), however efforts were made to minimize such effects. The subject content and order of the scheme of work remained unchanged, unless required for external exam preparation, and individual lesson objectives were as in the previous year wherever possible. Similarly the text book scheme, which is already informed by a social constructivist paradigm (CIMT 2000, *qv* CIMT 2004), remained unchanged; indeed the scheme used provides a number of Internet based interactive resources and is freely available in digitised form, happily facilitating its incorporation within a VLE. From the discussion above, it was anticipated that some changes in

pedagogic style might be brought about directly through the use of the VLE: the author reflect critically on such changes and kept a journal documenting these, as well as the management and teaching decisions made during the pilot stage. Other changes in approach, not a result of VLE implementation, were minimized, even if they could not be eliminated entirely (*cf* Gibbs 1999, p224, Dougiamas & Taylor 2003, p6). A more thorough investigation of the pedagogic changes brought about through VLE implementation would be an interesting topic for a larger scale study.

Despite such efforts, some bias undoubtedly remains in the collected data and it is difficult to imagine that results obtained could be generalized to contexts different from those in which the pilot study took place. Becta (2003) warn than reported benefits in commercial case studies may be “a function of the various schools that have piloted systems” (p38). They also warn that effects may be unsustainable as the systems mature and that novelty or Hawthorne effects may play a part (*qv* Shields 1996, p412). However, Carswell *et al* (2000, p45) claim that in fact students’ experiences of such systems improve after the first year, as usage becomes more sophisticated. A larger scale study over a longer period would be of value.

The difficulty of obtaining control data in educational research is well documented (*eg* Johnson 1994, p30-32). As the author teachers at a small school, there are no parallel maths groups which might provide comparison data, and designs in which comparisons are made with other subject areas or other schools have been rejected as a large number of additional factors would be involved, whose effect could not easily be isolated. Again, such difficulties could be, at least partially, overcome in a larger scale study with a greater longitudinal frame of reference, but even here some comparisons may be made through using historical assessment data, as discussed below.

Johnson (1994, p79-82, *qv* Busher 2002) highlights several of the ethical considerations resulting from research conducted within one's own institution, which are perhaps even greater when educational researchers uses their own pupils as subjects. The author's headteacher authorized the pilot study (*qv* Johnson 1994, p77) and teaching colleagues were kept informed. Consent for their daughters to use the VLE for completion of homework and, separately, for the use of confidential data (*ibid*, p81) on their daughters' use of the system, was sought from the parents of those girls involved; these parents will be given opportunity to see the system for themselves and ask questions about the system and the study, thus addressing the need for informed consent (*ibid*, p80, Cohen *et al* 2000, p50-53, Busher 2002, p83-85). Furthermore, an indication of the availability of home computing facilities was obtained at this stage, so that access issues may be addressed if necessary. Usage of the VLE and the nature of this research was described to the pupils (Morgan *et al* 2006, *qv* Carswell *et al* 2000, p45), who will also be given the opportunity to partially or completely opt-out (*qv* Cohen *et al* p52-3), even though Williams (2002) warns that "Students tend not to participate in the electronic environment unless they have to" (p268, *cf* Hughes & Daykin 2002, p217). Although no pupils did 'opt-out', usage patterns naturally varied, which provided an additional control factor. Upon completion of the study, the author presented its findings to school stakeholder groups, including the pupil participants (Busher 2002, p85), and has disseminated its findings more widely (eg Kenny 2006, Berry 2006), including to the VLE development community referred to in Appendix 2 below (*qv* Lomax 2002, p136), which describes in more detail the process of VLE selection for the pilot study

Approaches to learning

In assessing the extent to which Moodle has affected pupils' approaches to learning a range of qualitative and quantitative data collection methodologies were used (*qv*

Carswell *et al* 2000, Montieth & Smith 2001, and McPherson & Baptista Nunes 2004), in order to provide a broad picture of something that is perhaps intrinsically hard to measure.

An on-line survey of pupils' perceptions of mathematics lessons at the beginning and at the end of each term of the pilot study (*qv* Fogelman 2002, p95) was administered to all pupils taking part in the study – by administering the survey as part of their lessons, response could be maximized and additionally a degree of critical reflection promoted (Dougiamas & Taylor 2003, *cf* Bell 2002, p168). The purpose, importance and confidentiality of the survey was explained to the respondents (*qv* Johnson 1994, p81). The pupils were already familiar with completing surveys on their maths lessons, as the author has found this a useful way of gathering feedback on his teaching, and they were aware that their responses would be treated confidentially and that negative feedback had no adverse effect on their relationship with their teacher. The author is conscious that changes in pupils' attitudes may not be directly the result of the VLE implementation, but in the absence of control group data, this problem seems unavoidable; nevertheless, correlation analysis of this data with measures of VLE usage might still allow valid conclusions to be drawn, and thus completion of the questionnaire could not be conducted anonymously.

Moodle includes two built-in, validated survey instruments (Dougiamas and Taylor 2003) for assessing students' perceptions, preferences and attitudes. Used appropriately, these can provide easily analysable quantitative data; their use can be seen as an intrinsic part of the use of this particular VLE (Dougiamas & Taylor 2003); and comparisons can be made with use of Moodle elsewhere. The Constructivist On-Line Learning Environment Survey (COLLES, Taylor & Maor 2000) measures students perception of professional relevance, reflective thinking, interactivity, cognitive demand

and interpretation of meaning, with clear links to the constructivist learning goals (Cunningham *et al* 1993) used in the literature review above. In the context of primary education this survey almost certainly could not be used without change as the language is rather advanced and notions of ‘relevance to professional practice’ rather remote from the experience of 11 year olds. The author therefore modified the questions to more child-friendly language and greater relevance to primary practice (Johnson 1994, p38-39). The modified language version (appendix 3) has been made available for peer review through the Moodle discussion forum (Berry *et al* 2004), and its use is to be piloted with one of the sets (*ibid*, p39-40) prior to use with all groups (*qv* Bell 2002, p167-8). The language adjustment means that results may no longer be directly comparable with those from an unmodified COLLES, but the intention has been to remain true to the spirit of the original questions.

Such instruments can merely provide evidence of pupils’ perceptions rather than of actual changes in their approaches to learning and so additional methods are necessary. A further source of quantitative data was the log files produced through use of the VLE (*qv* Gibbs 1999), and analysis of these provided information on the extent to which pupils have used the tools available. Although pupils were made aware of activity logging, and consent was obtained for use of this data, this method is akin to the unobtrusive measurement discussed by Johnson (1994, p33), thus increasing the likelihood of authentic observation (*cf* Busher 2002, p85). Furthermore, the automated nature of the logging minimized the dangers of observer bias identified by Moyles (2002, p179). Whilst this information was of limited intrinsic value in addressing the research question, it provided useful correlates with other variables.

More importantly, by archiving discussion threads, use could be made of students’ ‘conversations’ as data sources, and qualitative techniques could shed light on the

processes and products of learning. (Winn 2002, *qv* Hughes & Daykin 2002, p218, Lobry de Bruyn 2004). Such a data source sits somewhere between observation-as-participant and use of closed access, personal documents (Scott 1990) in Johnson's (1994) description of research tools. This difficulty of classification seems to be inherent in Internet based communication, which, although textual in nature, has many of the features of verbal communication (Fox 2002). Furthermore, the ready availability of such rich data sources helped to offset the problems caused because

“Traditional methods for observing, recording, and analysing learning are inadequate for dealing with learning that results from interactions of several learners with complex learning environments.” (Winn 2002, p344)

Again, ethical concerns over the use of observation or documents written for other purposes (Busher 2002, p83) were addressed by initially obtaining informed consent and through reminders that discussion threads were archived.

A fourth data source is provided through the on-line journal tool available in Moodle, which allows a learner to maintain a private journal of their learning experience, accessible only by them and their teacher. In the pilot study, use of these journals was optional for pupils (as this represents a further change from existing classroom practice), and relatively few pupils made use of the facility. Had more done so, it could have provided more considered data than discussion threads alone (*qv* Johnson 1994, p63-66). However, by allowing pupils to choose for themselves whether to participate in this aspect of the pilot, which promoted a sense of control and independent learning skills, a certain non-participation bias (*op cit*, Hoinville *et al* 1978) was introduced and so care would be exercised in drawing conclusions from such data.

An additional data source emerged during the course of the pilot. Year 6 have the opportunity to engage in an extended, independent project as part of their maths

curriculum, which in the pilot year took the form of a statistical investigation. One pupil chose to survey her classmates' opinions on usage of the VLE using five 5 point Likert scales. Although not an extensive survey, her results (Skinner 2005, cited with permission, *qv* Morgan *et al* 2006), provide semi-independent corroboration of other data. Her subjects were assured anonymity, and thus correlation with other pupil level data was not possible.

A final data source for pupils' approaches to learning was the formal and informal feedback given orally in class discussions or individual conversations. It remained important to retain traditional channels for pupil communication, as, particularly during the pilot study, it was possible to imagine some pupils feeling alienated from their learning because of the introduction of the VLE. Notes were kept of these discussions and conversations, some of which resulted in changes being made to the VLE as part of the iterative action research methodology adopted here.

Pupil Attainment

In seeking to establish the effectiveness of the pilot implementation, it was appropriate to consider measurable learning gains alongside evidence for improvement in pupils' approaches to learning (Davey *et al* 2001, p173, Barbera 2004). The absence of a scientifically constructed control group in action research of this nature made it difficult to isolate learning gains brought about because of the VLE from those which, it is hoped, would have occurred normally over the course of a year's lessons (*qv* Visscher & Wild 1997, p266). However, use of historical data on pupil attainment from prior cohorts permits a form of quasi-experimental design (Cohen *et al* 2000, p214-5) and, to the extent that other aspects of their curriculum remain unchanged, analysis may allow some conclusions to be drawn with a degree of validity.

In order to use such historical data, it was necessary to use the same testing regime used in earlier years. Fortunately (or unfortunately...) the school has a relatively comprehensive program of external, and in many cases standardized, testing in place (*qv* Cohen *et al* 2000, p317-321). In order to facilitate data analysis and more direct comparison between the two pilot study cohorts (Year 5 and Year 6), progress indicators were restricted to the standardized scores obtained from QCA Optional Tests and National Curriculum 'SATs', taken in June of Year 4 (pre-test measure for the Year 5 group), June of Year 5 (post-test for Year 5 and pre-test for Year 6) and May of Year 6 (post-test for Year 6).

Such pupil assessment data was handled confidentially. Comparisons between one cohort's scores and another's may be misleading due to different levels of ability in the individual pupils, therefore further statistical analysis was necessary in order to obtain measures of average *progress* rather than attainment *per se*.

The problems with assessment discussed in the literature review above are, regrettably, inherent in this methodology. In particular, it is possible that the learning gains brought about through use of innovative technology such as a VLE may not be measurable in a conventional testing regime as used at the school. A case could certainly be made for giving students credit for collaborative work (Winn 2002, p346), and Smith & Wild (2001,p158) advocate replacing testing with the evaluation of real practices or practice simulations: such alternative approaches to assessment of VLE learning gains could usefully be explored in a larger scale study.

Analysis

A range of statistical techniques were used for quantitative analysis of data obtained in the pilot study, including binomial testing of proportions, paired and unpaired t-tests of means, chi-squared contingency tables, correlation analysis, and multi-dimensional linear modelling. Although not described in detail in the following discussion in the interests of narrative flow, statistically significant results are given, together with a measure of their significance, in the form $P=x\%$, or $P<x\%$.

Knowledge Management

The author admits to some disappointment that there were only 33 responses to the online survey, of which only 30 were UK based and 26 from those in schools. Although the web-based nature of the survey made it impossible to ascertain how respondents learnt of the survey, responses suggest that few, if any, of the commercial VLE suppliers and RBCs contacted had passed on details of the survey to their users. At the time of the survey (Feb-March 2005), VLE usage in schools was still relatively limited, and thus there was a small population from which to garner data; Schoolnet's own survey (EUN 2003) received only 24 responses from the UK. Thus, no claims can be made that these results are representative; however they do present a snapshot of VLE usage at this point in a handful of institutions.

The self-selected sample of schools from which responses were received includes a significantly higher proportion ($P=4\%$, see Figure 1) of primary schools than in the Schoolnet survey (*ibid*, Annex III), although given the author's position within the primary practitioner community, this should not be interpreted as indicating differentially increased take-up of VLEs within this phase.

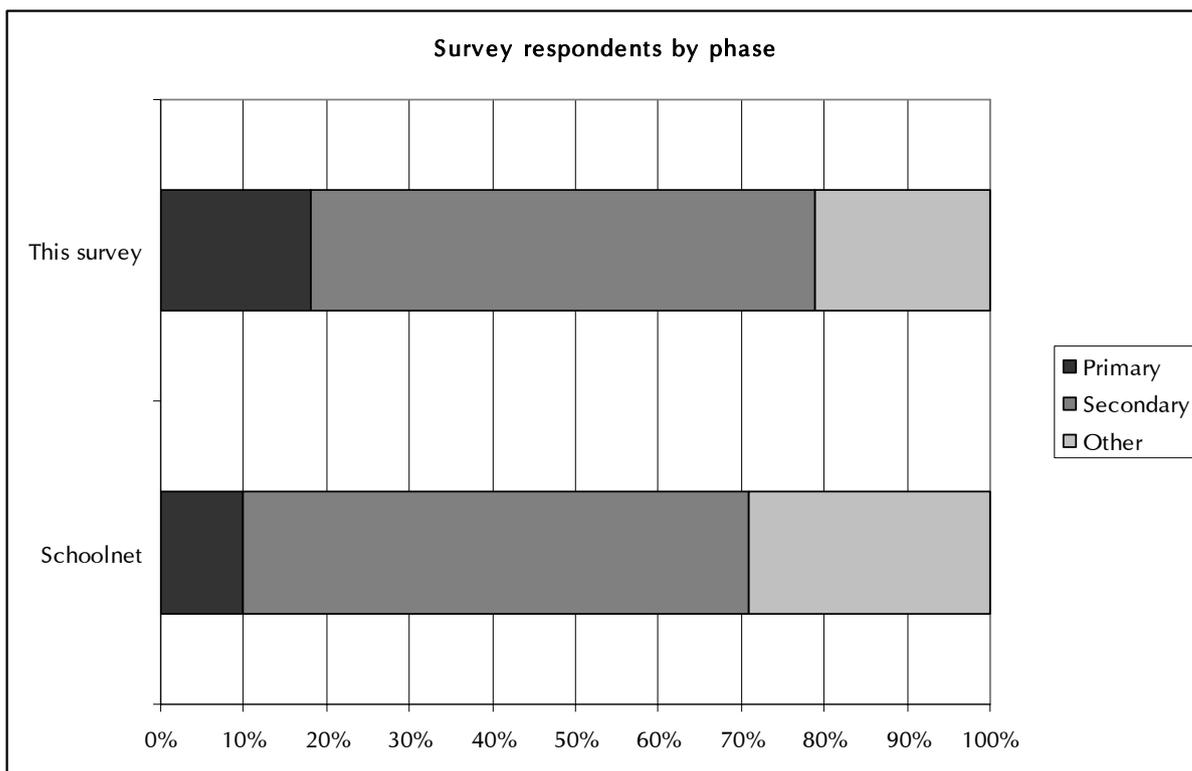


Figure 1 Comparison between Schoolnet survey (EUN 2003) and this survey showing phase of education.

Similarly, a significantly higher proportion of respondents (P=2%) were employed in independent schools than would be found in a random sample of the teaching workforce (DfES 2006), but this too may reflect the author’s community of practice rather than suggesting higher proportions of VLE usage in this sector, although the greater autonomy enjoyed by independent schools, and perhaps a need for a competitive advantage are perhaps factors here.

There was a significant difference (P<1%) in the type of VLE used by those responding to this survey and to Schoolnet’s, with higher proportions favouring open source software, and rather fewer developing their own solutions in-house, or at local or regional level (Figure 2).

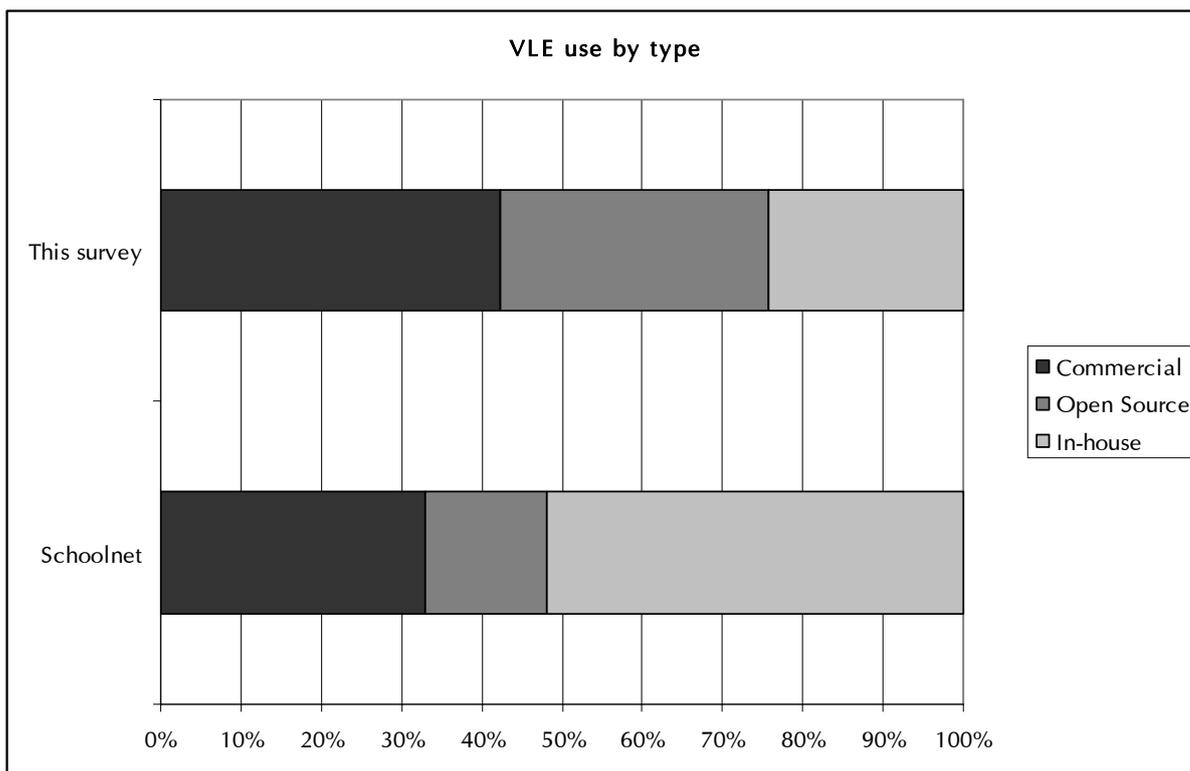


Figure 2 Comparison between Schoolnet survey (EUN 2003) and this survey showing VLE use by type.

Much of the reported increase in open source solutions is due to use of Moodle, used by seven of the 33 respondents in this survey, including four of the six primary schools, but not mentioned by any of Schoolnet’s respondents. OSS Watch’s survey (2006) indicates Moodle is now used by 56% of FE institutions; however no figure is available for the school sector. There were no significant differences in VLE use across sector or phase. Unsurprisingly, significantly more (P=3%) of those using in-house or open-source VLEs reported making some contribution to the software’s development than with commercial code, although one commercial VLE user commented that the developers were “excellent in the way they helped 're-develop' the product to suit our needs”.

A number of the tools which Schoolnet’s respondents used were significantly less commonly available from respondents in this survey: external email, tools to manage mailing lists, voice over IP, and peer to peer tools (P<1% in all cases). It is likely that

respondents here had access to some of these tools through other systems. A generally similar level of tool provision existed between phases, although secondary users did seem to have access to some additional tools: shared calendars, tools for online course creation, metadata creation and survey design ($P < 1\%$ in all cases). Independent schools were less likely to provide forums ($P = 3\%$) and task assignment tools ($P = 3\%$), although otherwise tool provision was similar between sectors. Open source, in-house and commercial systems were reported as providing similar toolsets; the only significant exception being that open source systems were more frequently reported as providing chat tools ($P = 3\%$).

Respondents reported use of the various tools provided through the VLE, where they were available, was generally in line with the results obtained in Schoolnet's survey (*ibid*), see figures 3 and 4.

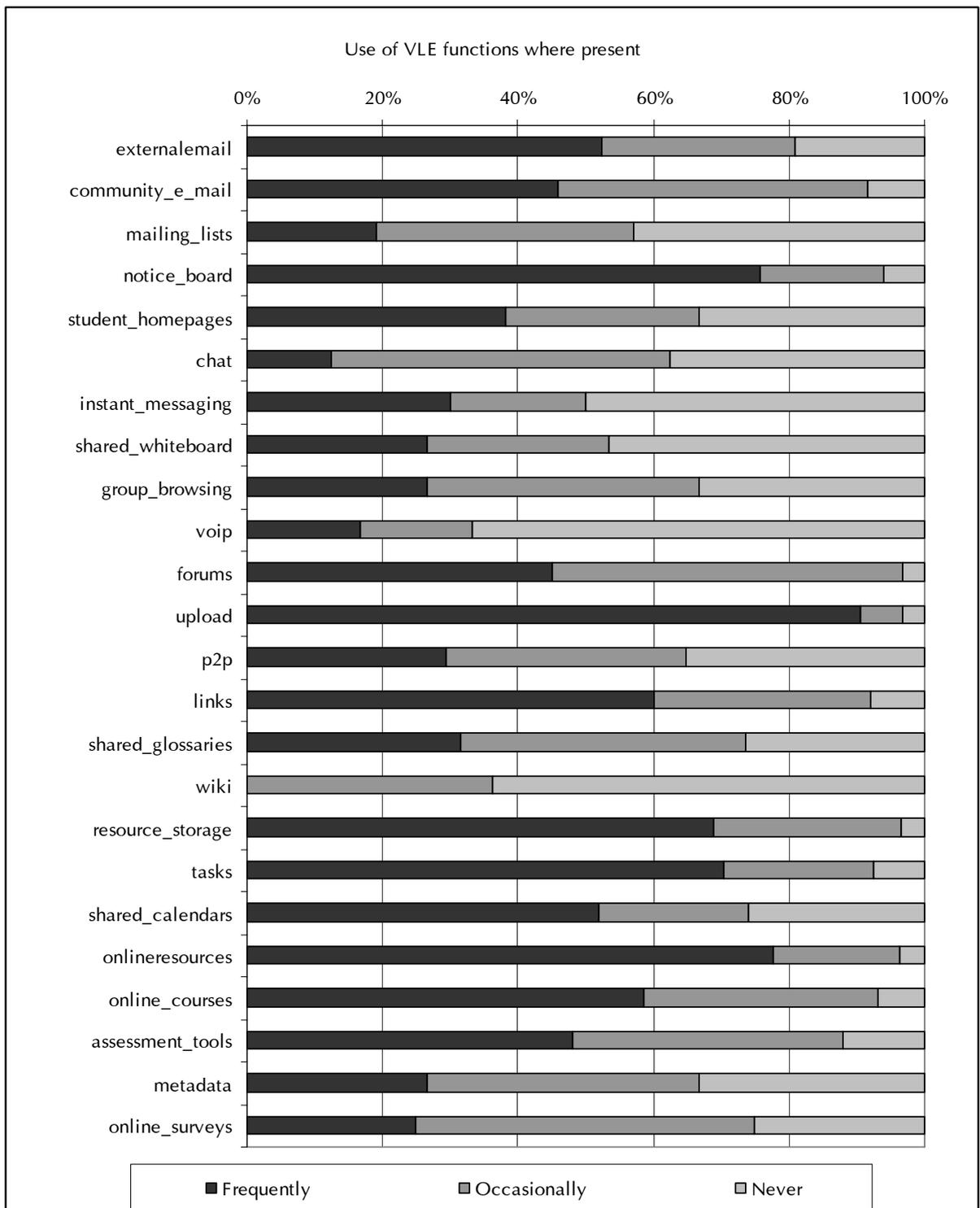


Figure 3 Reported use of VLE tools where present (this survey)

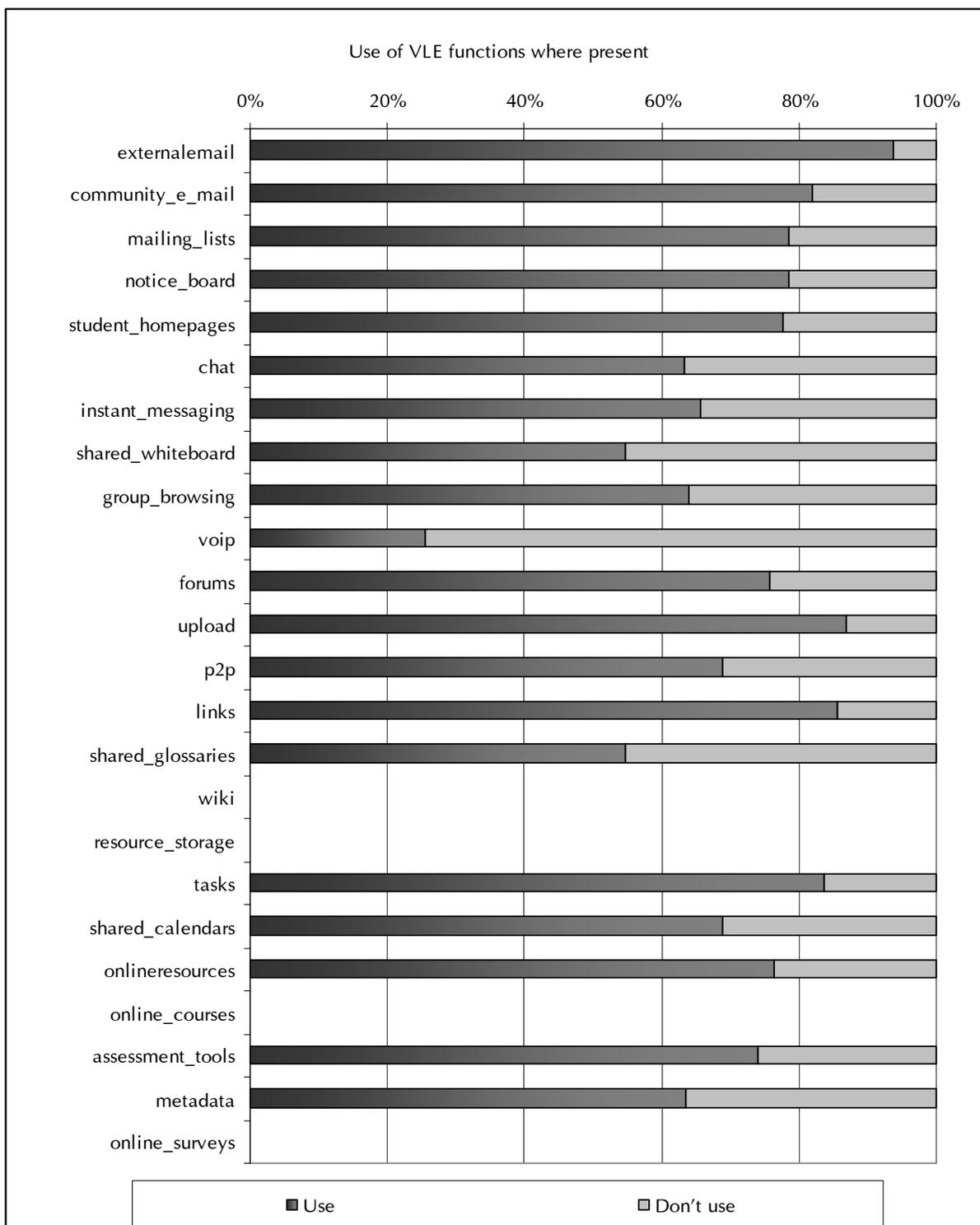


Figure 4 Reported use of VLE tools where present, Schoolnet survey (EUN 2003, Annex III p19) (NB present survey included four additional tools, shown as blanks above)

There were significant differences from the Schoolnet sample in the use of a few tools, with smaller proportions using tools for external e-mail (P=2%) and mailing list management (P=2%), and higher proportions using the tools for notice boards (P=3%), discussion forums (P=1%) and online resource creation (P=1%), perhaps suggesting a greater propensity to use web based rather than e-mail based systems. There was no significant difference in tool use between sectors, and the only significant differences in usage between phases were a greater frequency of mailing list use in secondary schools (P<1%), as no primary schools used this tool, and more frequent use of the VLE to assign tasks to students in primary schools (P=1%). Those using open source systems made more use of peer to peer tools (P=4%), and those using commercial software made more use of shared whiteboards (P=2%). Community e-mail seemed more frequently used when respondents had participated in VLE development (P<1%), as were peer to peer tools (P=2%), lists of links (P=1%), shared glossaries (P=2%) and survey tools (P<1%), suggesting that where respondents had been involved in the development of the software, a greater range of the provided tools would be used. Predictably, there were high degrees of correlation between the extent to which one tool was used and another. Particularly noteworthy are group browsing, where there was significant (P<5%) correlation with 15 of the other 23 tools, online resource creation, file upload and task assignment (11 correlates each). There was significant *negative* correlation between use of tools to manage e-mail lists and ten of the other tools, suggesting that this tool may now have been superseded by simpler, web-based affordances.

Thus, the demographics and VLE usage of the self-selecting sample of schools in the present survey is for the most part comparable to the Europe-wide self-selecting sample surveyed by Schoolnet. Such differences that do exist are most probably explained by the additional two and a half years of VLE development, although some allowance might be

made for the UK focus, the relatively higher proportions of independent and primary schools, and the greater use made of open source software.

Given the focus of this part of the study, responses to the knowledge management specific questions, summarised in Figure 5 below, deserve more detailed discussion, with the order here broadly following that in the literature review (p19-23 above). Again there was extensive correlation between responses, only some of which are discussed below. There were no significant differences in opinions between maintained and independent sectors or between primary and secondary phases on any statement, nor were there significant differences between those responding in regard to their own teaching and those considering the overall provision within their institution.

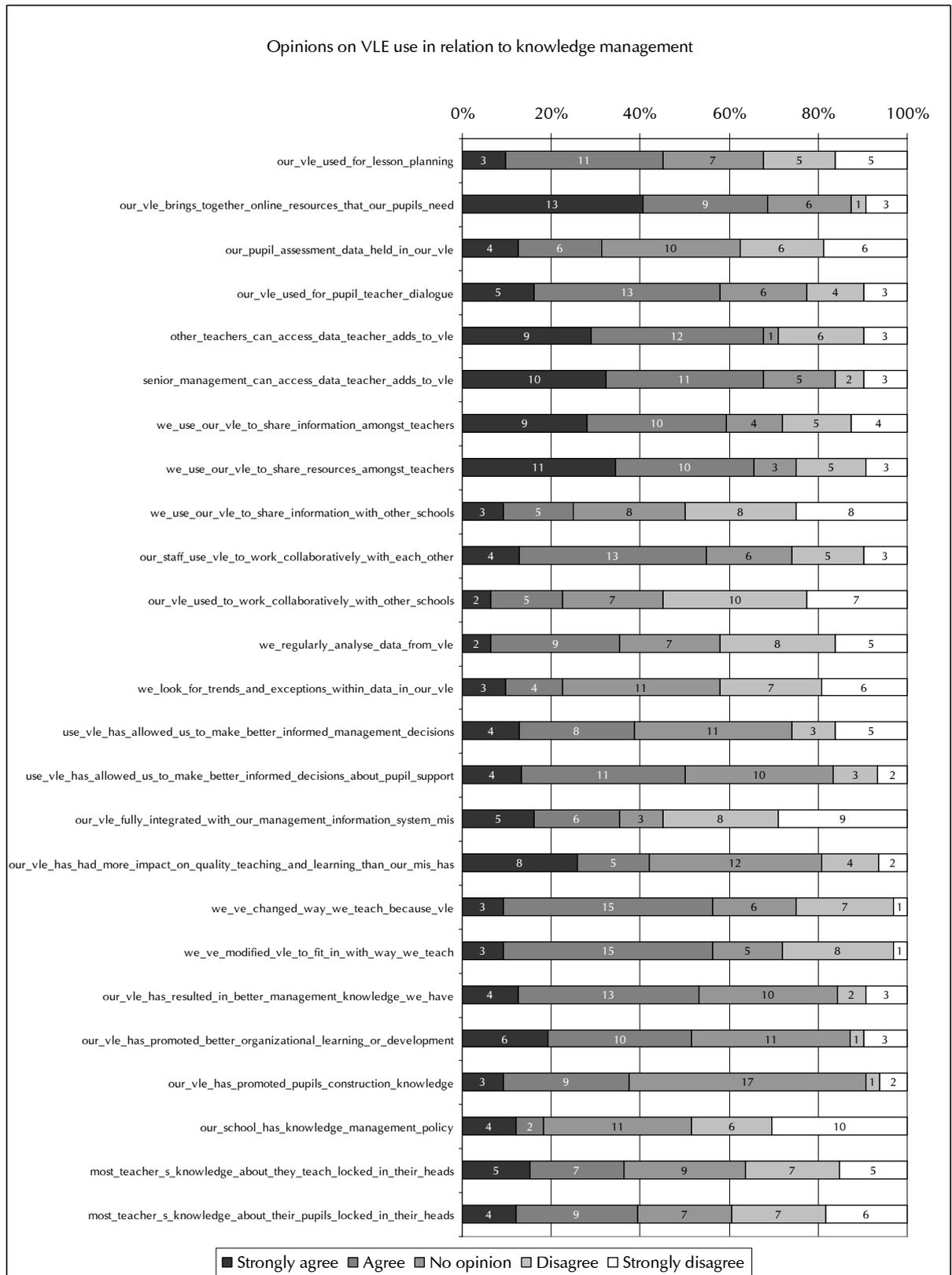


Figure 5 Opinion on VLE usage in relation to knowledge management

The balanced (and highly correlated, $P < 1\%$) responses to the final two questions, “**Most of a teacher’s knowledge about what they teach is locked in their heads**” and “**Most of a teacher’s knowledge about their pupils is locked in their heads**” suggests that there was little consensus amongst respondents as to the extent to which teachers’ subject and pupil knowledge is necessarily tacit, which is perhaps unsurprising given the limited interest in knowledge management within education. This view seems supported by the small number (6) of positive responses to “**Our school has a knowledge management policy**”. None of these three statements, which sought to address broader knowledge management understanding, had extensive correlations with the other VLE specific statements, although schools with knowledge management policies were more likely to analyse data regularly ($P = 4\%$), and look for trends and exceptions in the data ($P = 1\%$). Importantly, they were also more likely to have integrated their VLE and MIS provision ($P < 1\%$). Those who took a more tacit view of teachers’ subject and pupil knowledge were less likely to afford senior management access to teacher’s VLE data ($P = 4\%$ in both cases), or to use the VLE to inform decisions about pupil support ($P = 3\%$ in both cases). They also made less frequent use of group browsing, file upload, and task allocation tools, and, in the case of those taking a tacit position on pupil knowledge, were less likely to have integrated VLE and MIS systems ($P < 1\%$), although it may be hard to identify cause and effect in this case.

The use of VLEs to make explicit some aspects of teachers’ knowledge is relatively mixed, with more than half of the respondents **bringing together online resources** in their VLE and **using the VLE for teacher pupil dialogue**, but rather less using VLEs for key information management functions such as **lesson planning** and **assessment data** (where VLEs were used by less than a third), although one imagines that these

schools had other systems in place here. Use for lesson planning and for bringing together resources both correlated extensively with other aspects of use for knowledge management, (11 and 13 other statements respectively), and all four of these dimensions correlate with collaborative work amongst the staff. Those using VLEs for lesson planning, to hold assessment data, and as a way of bringing resources together find them particularly helpful in promoting organizational learning and knowledge management ($P < 1\%$ in all cases). Within each VLE, use of group browsing, peer to peer, link management, and metadata tools correlated with most of these statements; there was a link between those using VLE assessment tools and those using the system to manage assessment data ($P < 1\%$), and collaborative tools (wikis and shared glossaries) were also being used more by those who saw their VLE as a way to bring together resources for pupils ($P = 2\%$ for both).

Respondents were on the whole more positive about the use of their VLEs as tools for sharing data, information and resources within the school, with over half agreeing with each of the four statements in this group, with over two-thirds providing **access to data for other teachers** and **senior management**, with this latter group being significantly more likely to have access when respondents had participated in the VLE's development ($P < 1\%$). There was a high level of inter-correlation in response to all four of the statements in this cluster ($P < 5\%$ in all cases), which also all correlated with use for collaboration within the school and, except for the senior management statement, with collaborative activity beyond the school too ($P < 3\%$ in all cases). By making access to data available to other teachers (rather than specifically the SMT), and using the VLE to **share information** and **resources** amongst the staff, there seemed to be a corresponding perception that the VLE had made more of an impact on teaching than the school's MIS ($P < 5\%$ in each case), perhaps because these respondents felt that they

had changed the way they teach because of the VLE's introduction ($P < 2\%$ in each case). Furthermore, there was a clearly perceived gain to organizational learning and knowledge management from VLE use for these purposes ($P < 5\%$ in all but one case). Affording other teachers access to data correlated with use of 12 of the VLE tools, with metadata, shared glossaries, file upload, group browsing and student homepages all recording high correlations ($P < 5\%$) with three of these four statements.

Although **collaborative work through the VLE within the school** seemed relatively common, only seven respondents agreed that they used their **VLE to share information with other schools** or to **work collaboratively with other schools**, although it is unclear whether this is as a consequence of organizational culture or of interoperability issues with the still immature VLE products then available. There was however a high degree of inter-correlation within this cluster of statements ($P < 1\%$ in all cases), and with the preceding cluster ($P < 2\%$ except in relation to SMT data access) suggesting that once a school becomes use to internal VLE mediated collaboration and sharing, they become more willing to extend this practice beyond the institution's boundaries. Collaboration amongst the staff correlated with 15 of the other 24 statements in this section of the survey, suggesting that this might be a crucial dimension to an organization's culture if they are seeking to improve their use of this technology to manage their shared knowledge; the VLE tools most closely correlated with this were community e-mail, student homepages, file upload, link management, shared glossaries, metadata support and provision of online surveys, rather than more explicitly collaborative tools like wikis and forums.

Regular analysis of VLE data and **looking for trends and exceptions** seemed relatively uncommon (with only seven respondents engaging in the latter), perhaps because few had achieved any degree of **integration with their MIS**, which may

consequently have limited the scope for the VLE to contribute to **better informed management decisions**, although somewhat more, but still less than half of the respondents, found that the VLE had helped make **better informed decisions about pupil support**. Interestingly, regular analysis of data seemed more prevalent amongst users of non-commercial systems ($P < 1\%$) and where respondents had participated in the systems development ($P < 1\%$); these (overlapping) groups were also more likely to look for trends and exceptions ($P = 2\%$, $P < 1\%$ respectively). Similarly, users of open source systems were more likely to find the VLE helpful in informing management decisions ($P = 3\%$). These results may be because of greater responsiveness to the actual rather than perceived information management needs of schools, as Kirkup *et al* (2005) found in their study of schools' use of data:

“School-devised systems ... tracked individual pupils and allowed schools the flexibility to input internally generated data such as interim assessments and targets; i.e. such tools were easier to customize to the school and its particular needs and circumstances.” (p1)

There was again a high degree of inter-correlation within the statements in this cluster ($P < 1\%$ in all cases), although relatively little cluster-wide correlation with other areas, except perhaps where schools had knowledge management policies as remarked above. Although there was a link with the use of VLE assessment tools ($P < 4\%$ in all but one case), there were also surprising correlations with chat, group browsing and peer to peer tools ($P < 5\%$ in all cases), which the author would struggle to explain. There were significant negative correlations between mailing list management tools and responses on better informed decision making ($P < 1\%$ in each case), perhaps because such a tool does not support fine grained access to individual data.

Responses to the cluster of statements focussed on the interrelationship of the VLE with organizational culture as a whole suggested a moderately positive effect from the introduction of a VLE, with slightly more than half agreeing that **the VLE had changed teaching**, but also that **the VLE had been modified to fit with the way they taught**, and that the VLE had a positive impact on the **management of knowledge** and **organizational learning**. There was somewhat more equivocation as to **whether the VLE or MIS had had the greatest impact**, and relatively few (12) agreeing that the VLE had **promoted pupil’s knowledge construction**, suggesting that the social constructivist approach to VLE use common in HE has yet to make much impact at school level.

The final section of the survey sought to identify experience elsewhere on the impact of introducing a VLE on learning and teaching activities. The results (Figure 6) were somewhat less than encouraging, with only around a fifth of respondents reporting any improvement on teachers’ or pupils’ approach to lessons, or on pupil attainment. Indeed, over three fifths of the responses disagreed with the statement that the VLE had raised the level of pupil attainment.

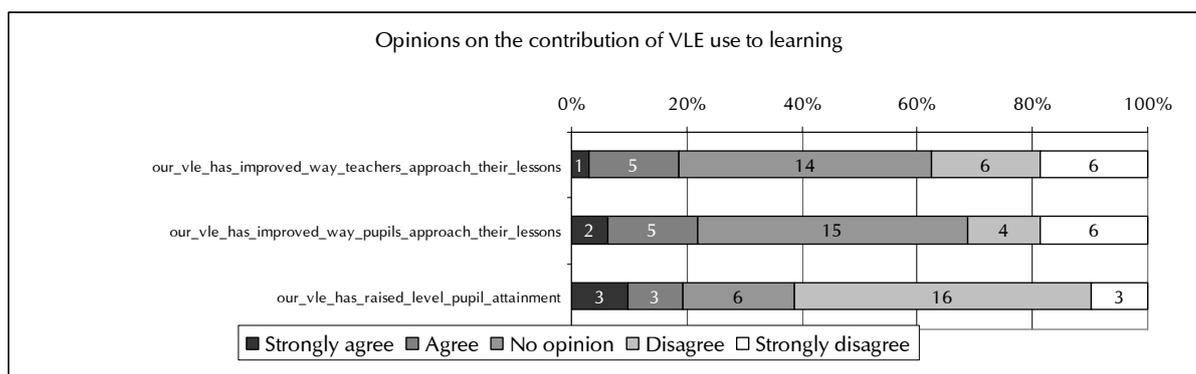


Figure 6 Opinions on the contribution of VLEs to learning

There was a very high degree of inter-correlation between the statements in this section (P<1% in all cases), given the linkage between teachers’ approaches and those of their

pupils, and the impact of both on attainment levels. Despite the not entirely positive support here for the potential impact of VLEs, agreement with these statements correlated extensively with the knowledge management related statements, particularly those in regard to the codification of teachers' knowledge ($P < 5\%$ in all but one case), and those in the organizational impact cluster ($P < 1\%$ in all cases), as well as individual statements on staff collaboration ($P < 1\%$ in all cases), and informed decision making ($P < 3\%$ in all cases). This suggests that the introduction of a VLE alone will *not* be sufficient to significantly impact learning and teaching, but that embedding the VLE within the organization's culture and practices might. Such organizational embedding is, of course, beyond the scope of the pilot study, which sought to identify the more direct effects of VLE introduction on pupils attitudes and attainment, the results of which are described below.

Introduction to the pilot study

Use of the VLE itself followed a blended approach (Clark 2003, *qv* Konrad 2003), with use in lessons being relatively limited, as a classroom already provided sufficient opportunity for collaboration, interactivity, and selection of resources, and the school perceived a parental expectation that girls be thoroughly prepared for pencil and paper based senior school entrance examinations. Pupils' study at home, however, could make extensive use of the VLE, as most daily homeworks were set in this way (*cf* Becta 2003, p28), although completion of homework in this manner was optional as printouts were available. Pupils undertaking homework in staff supervised, after school sessions had access to the VLE through the school network. Pupils additionally had access to discussion forums, online resources and further activities. The model envisioned from the start being that of *extending aspects of good practice from the classroom into the home environment*, such as access to a range of resources (Figure 7) and activities

(Figure 8), immediate feedback, (Figure 9), collaborative work (Figure 10), an opportunity to discuss work (Figure 11) and the facility to review parts of the lesson (Figure 12), this latter originally being a simple copy of notes from the interactive whiteboard, subsequently replaced with audio-visual recordings of the introductory phase of the lesson using a screen recorder with the interactive whiteboard.



Figure 7 Screenshot showing some of the range of resources available

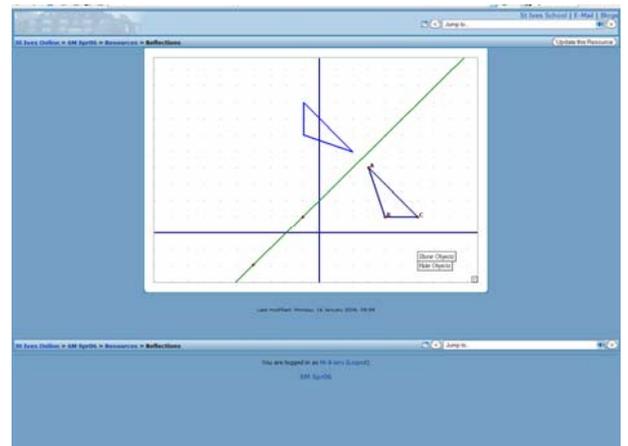


Figure 8 Screenshot showing interactive geometry activity

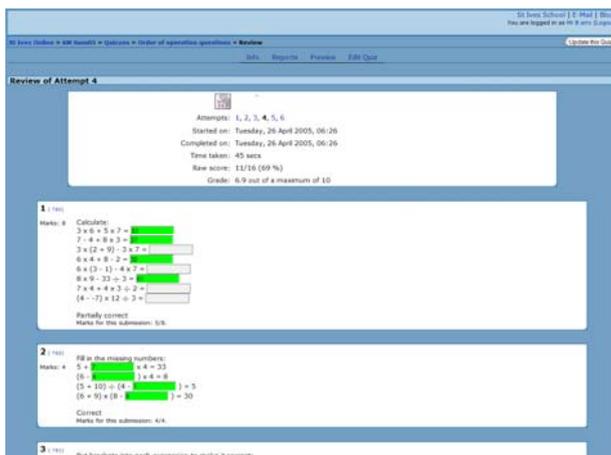


Figure 9 Screenshot showing immediate feedback from a homework quiz



Figure 10 Screenshot showing collaborative wiki activity



Figure 11 Screenshot showing discussion forum thread

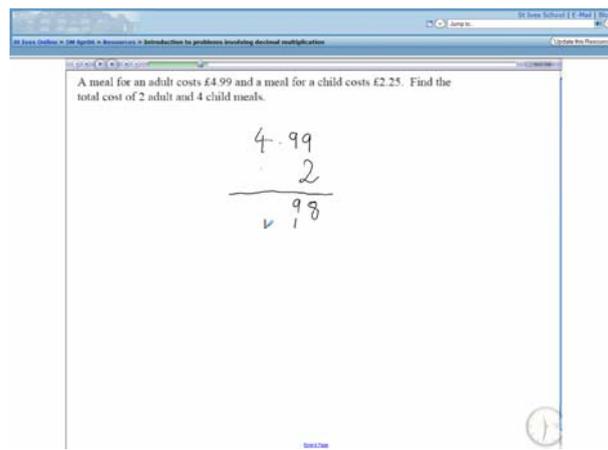


Figure 12 Screenshot frame from a lesson recording

Guidelines for the use of the VLE were drawn up and monitored (qv Rimmershaw 1999, p193), again using classroom conduct as a model. The experimental nature of the study meant that VLE use altered as the study progressed, subject to critical reflection on and documentation of such changes (qv Cohen *et al* 2000, p229, Taylor & Maor 2000, Dougiamas & Taylor 2003), of particular interest here was the need relatively early on to provide more detailed information to parents, careful monitoring of log files to ensure pupils did not spend excessive time in the VLE at the expense of other activities, and a need for care in creating the online mark schemes, as discussed below.

One clear piece of advice emerging from the literature seemed to be the importance of a positive first experience of the VLE, and so care was taken to ensure that pupils were acclimatized to its functions through a non-threatening introduction to the use of the available tools and perhaps somewhat less than usually challenging homework (Williams 2002, p267,269, Maor 2003, p206,210). Experience from the pilot study suggests that in school use, a similar introduction would encourage greater parental involvement. Parental involvement is an interesting issue here, given the focus in DfES

policy (2005a, 2005c) on using technology such as this to promote greater parental participation. Although parents were not provided with accounts on the system, several pupils had chosen to share their credentials with their parents. Parents, of course, have an independent right of access to a child's school records (Education (Pupil Information) (England) Regulations 2000), however several pupils reported that they would feel constrained in their contribution to forum discussions, and to recorded lesson segments, if they knew their parents would be reading or listening to their contributions (*cf* Hammond 1999, p357). There seems a tension here between parental access and pupil privacy, with additional complexities of child protection concerns.

Although concerns have been raised over hidden costs associated with open source VLE solutions in primary schools (Stolberg 2006), experience from the pilot study supports Becta's (2005) findings from their investigation of the total cost of ownership of open source desktop software, that significant savings can be made this way. In purely budgetary terms, use of existing hardware and free software kept costs to less than £100, this being the cost of upgrading the third party web-hosting account. The system provided a highly reliable service throughout the pilot study.

There were, of course, additional demands on the author's time: installing and maintaining the system was, in itself, not onerous, and amounted to no more than 20 hours over the course of the year's pilot; however creation from scratch of the online courses, including interactive quizzes for each night's homework, and participation in the VLE's online discussion forums amounted to on average 8 hours per week in term time, somewhat greater than the 30 minutes per week cited for use of a similar product (Becta 2003, 37); this was somewhat offset by a corresponding saving in marking time, and the ability to reuse courses and quizzes with minor adjustments in subsequent years, which, together with a willingness to step back from forum discussions to

encourage greater pupil participation, has since reduced this to more manageable levels. However given the DfES agenda for teachers' workload reduction (*qv* DfES 2005c), more widespread use of systems such as this would seem to require greater availability of prepared content, or collaborative course creation across a group of schools; this latter approach would have additional knowledge management benefits as discussed above. The author's participation in the Moodle user community, contributions to wider debate on this technology and more detailed record keeping in association with this study have been additional time burdens, however these would not generally figure in a typical teacher's use of such systems.

Approaches to learning

The online maths courses provided through the VLE were used regularly and enthusiastically by the pupils in both cohorts for the pilot study. Figure 13 gives an indication of the amount of use the system received over the course of the year.

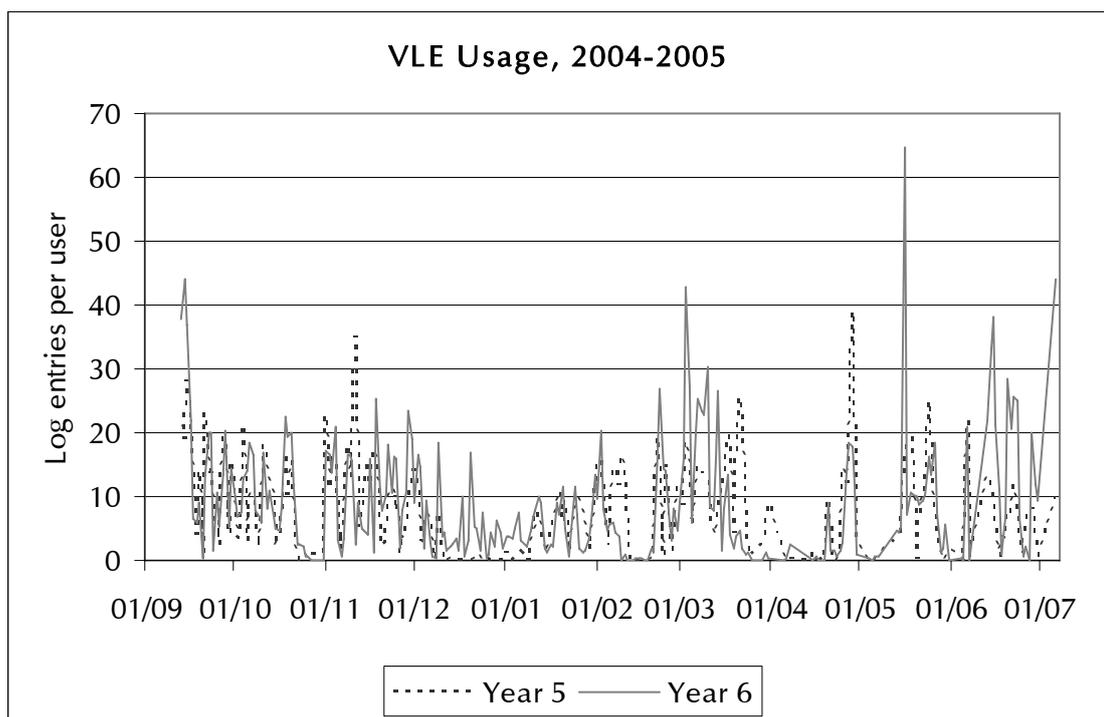


Figure 13 VLE usage 2004-2005

There is a high level of correlation between use in the two cohorts ($P < 1\%$), explained by the pattern of daily homework during the week, with few additional tasks at weekends or during holidays. The exception was the Year 6 Christmas holiday (see Figure 14), when these pupils continued to make extensive use of the VLE as part of preparation for high stake entrance exams for their senior schools. Several pupils reported, either via their online journals, discussion threads or orally, on the sense of community that this had engendered, that each didn't feel she was on her own as she revised. Analysis of the log files over this period indicated that several pupils were looking back over already completed quizzes and earlier forum discussions, indicating a strong sense of personal responsibility and more holistic view of their studies. Similarly, long-term absences from school no longer resulted in missed work or the need to catch up, as individuals were able easily to keep up with lesson content and homework, and importantly also felt able to keep in touch with their classmates.

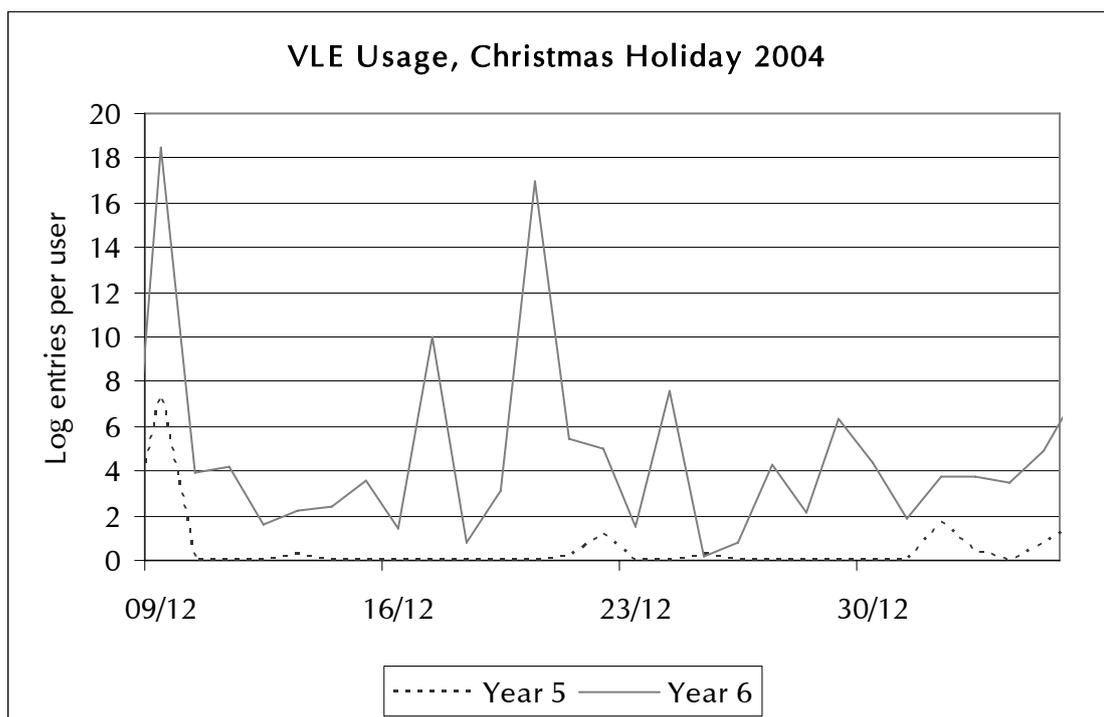


Figure 14 detail from the above, showing use over the Christmas Holiday, 2004-05

Year 6 pupils made significantly more use of the VLE (8.2 log entries per user per day) than those in Year 5 (5.4) ($P < 1\%$), perhaps reflecting greater maturity, or their focus on exams; however there was no significant difference in use between A and B sets. Within groups, usage varied considerably (Figure 15), with a small minority choosing not to use the VLE, or not being able to use it at home, for extended periods, for example because home access to the Internet was via a parent's business laptop.

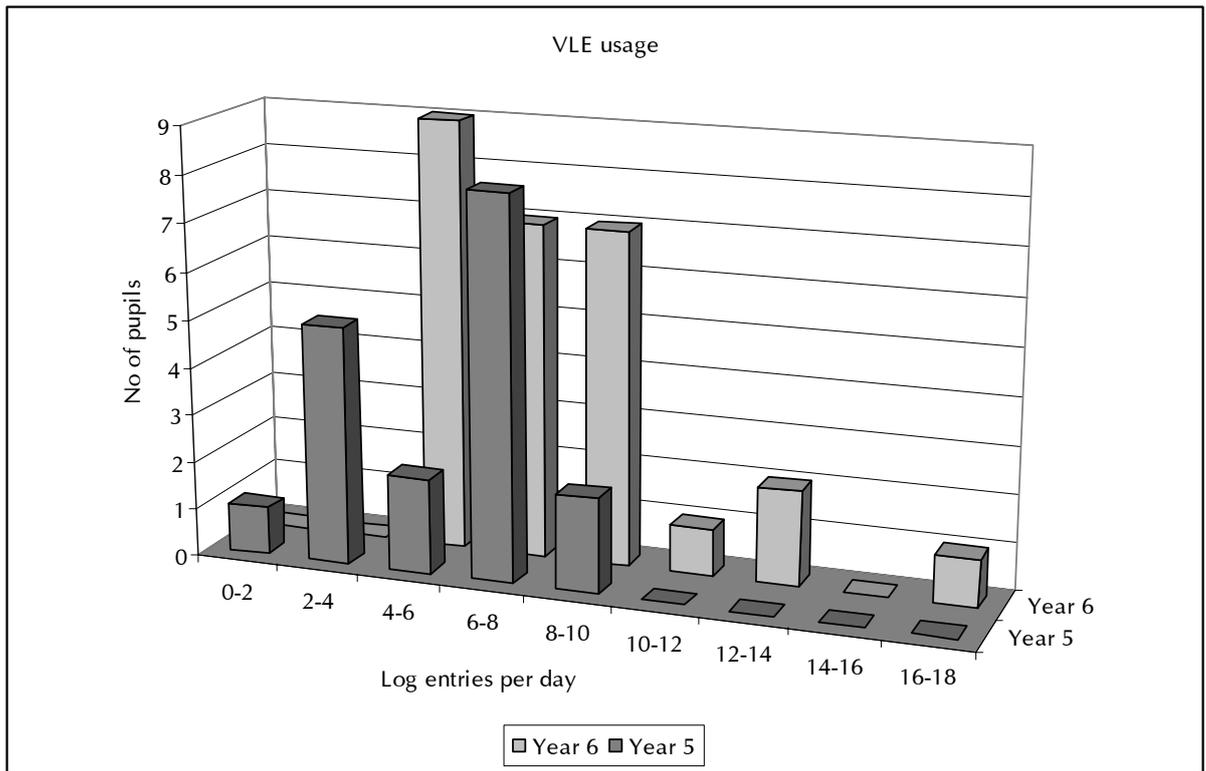


Figure 15 Variation in usage between pupils

When analysed module by module, a broadly similar pattern of use emerges for the two cohorts (see Figure 16).

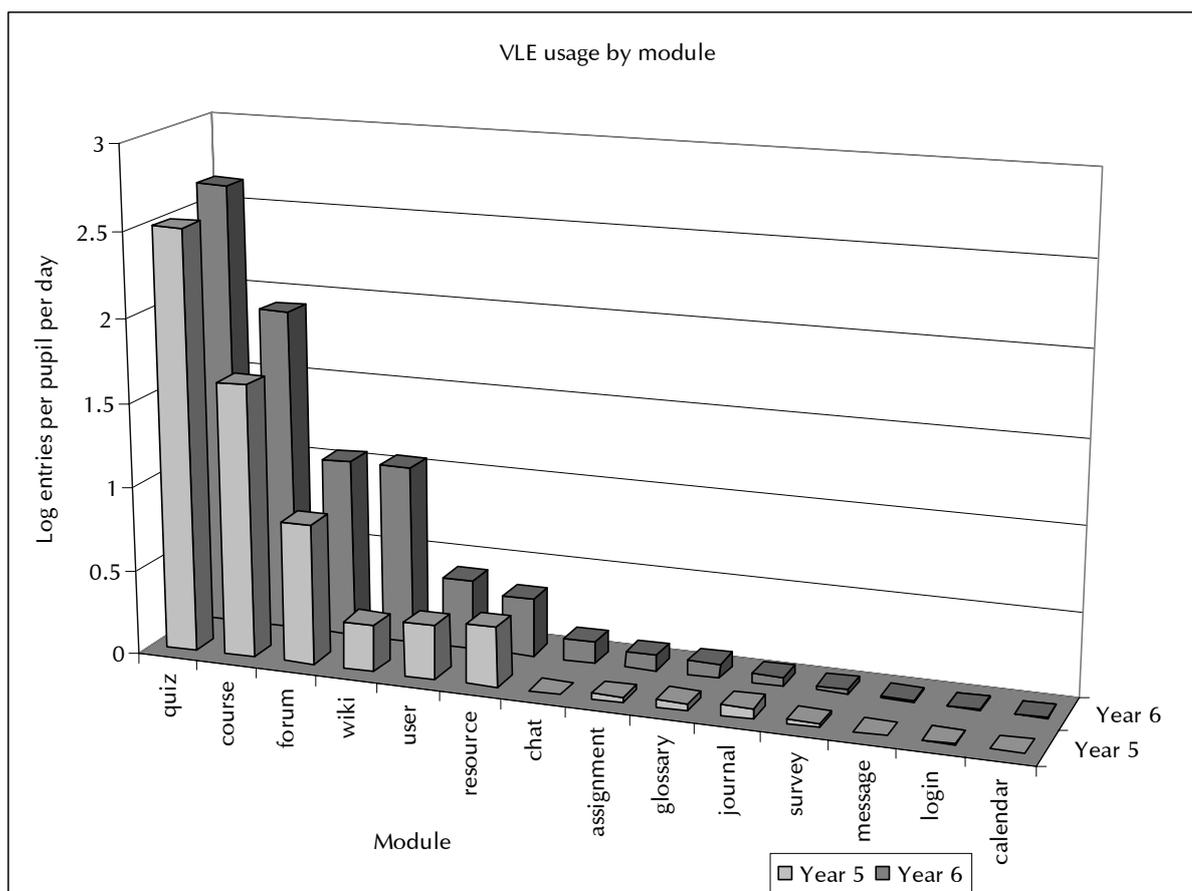


Figure 16 Module usage per pupil per day

Although it was anticipated that communication and collaboration tools would receive the greatest use within the social constructivist approach that the VLE was seen as promoting, in fact the somewhat more behaviourist Quiz module received greatest use, as this was the means through which daily homeworks were set. Analysis of log files, use of the teacher’s quiz review facility and pupil feedback indicated that many pupils perceived the immediate feedback and opportunity to learn from mistakes as one of the greatest benefits of the VLE:

“I enjoyed Moodle as when we do the homework we can have it marked straight away.” (Year 6 pupil, A group)

Although some parents and colleagues worried that pupils were simply guessing answers until they hit on the right one, detailed examination of attempt data provided

insight into pupils thinking and confirmed that such trial and error approaches were rarely used; furthermore, access to pupils' homework attempts prior to the following lesson allowed for more focussed, better informed teaching. Discussion forum contributions would often be provoked by matters arising from homework quizzes, and this aspect is discussed in more detail below. The greater use of the course overview module amongst the Year 6 cohort reflected their willingness to look back over earlier material, perhaps motivated by pressures of exam preparation. Use of the user module was related to a desire to establish a 'social presence' within the virtual environment, and again was more common amongst the more mature Year 6 pupils. Year 6 pupils made more extensive use of the wiki module for extended research led homework than their Year 5 counterparts: a list of mathematical terms might typically be provided, and then pupils would be encouraged to research these via the Internet, contributing some aspect of their understanding to the shared, editable webpages, which their peers would subsequently edit to add additional aspects or correct errors in earlier drafts: these were popular activities with the pupils who came to a greater sense of trust in their classmates through this process, which made explicit the concept of shared construction of meaning that underpinned much of the approach to mathematics taken by the school. Access to the chat module was restricted to Year 6 pupils over the Christmas holiday, as a way of diminishing the sense of isolation felt whilst revising for exams.

Patterns of use within the VLE thus suggested, perhaps particularly with the Year 6 pupils, willingness to contribute to forum discussions and work collaboratively, a mature approach to homework, in which the pupil takes responsibility for learning from their mistakes, and an holistic view of the syllabus in which prior learning is built on and can be revisited, all of which might be regarded as indicative of a positive benefit to pupils approaches accruing through use of the VLE.

Data collected as part of an independent project by one of the pupils (Skinner 2005, cited with permission), confirms the enthusiasm with which pupils had responded to the introduction and use of the VLE (Figure 17). The focus here was explicitly on the VLE’s use in homework.

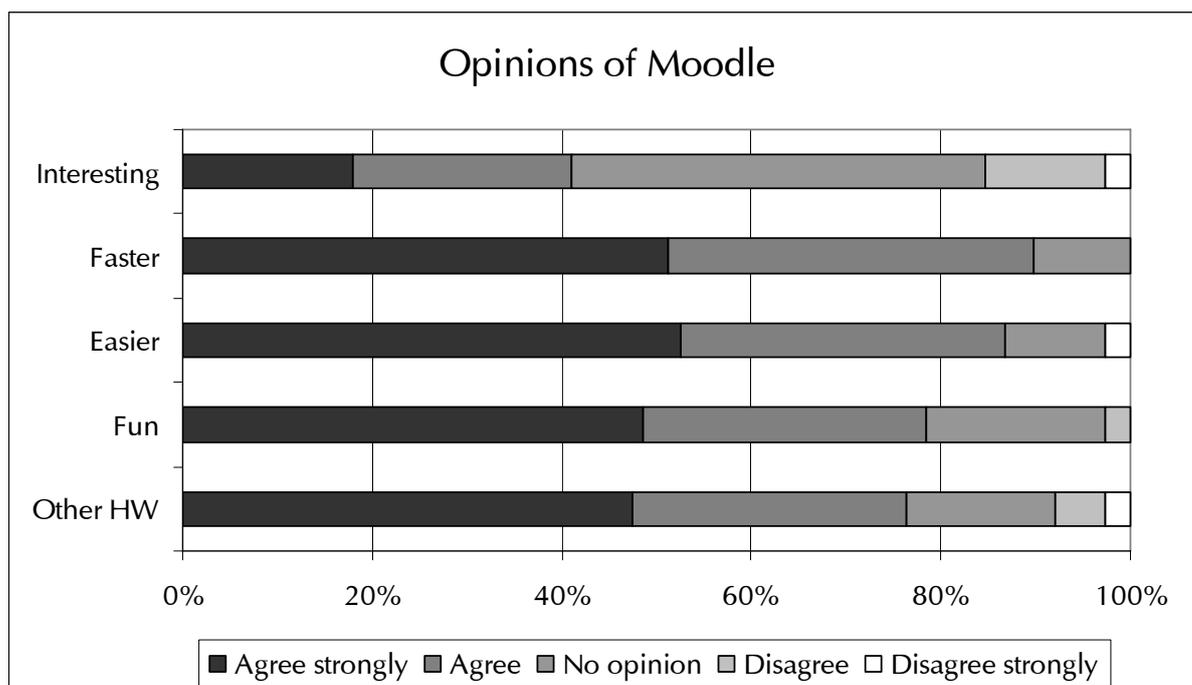


Figure 17 Survey of opinions of VLE usage (derived from Skinner 2005)

Thus, 90% believed homework to be faster on the computer, which the author’s subsequent analysis revealed was a view more strongly felt by Year 6 pupils (P=1%), and 87% felt that homework was easier this way (although the content of the course had remained unchanged through the pilot project). 76% hoped that other subjects would set homework this way (interestingly, this was a stronger preference amongst members of the lower ability B set, P=4%). Whilst 78% agreed that computer based homework was more *fun*, a mere 41% acknowledged it to be more *interesting*, although this latter view seemed rather more common amongst Year 5 pupils (P<1%).

Use of the COLLES survey instrument (Taylor & Maor 2000), at the start of the pilot and at the end of each term, provided a valuable opportunity for pupils to reflect on their learning from a different perspective, although even in its simplified language version (Appendix 3, *qv* Berry *et al* 2004), some explanations of the various statements were necessary for some pupils, although care was taken to avoid the introduction of bias. The results aggregated across each of the six areas of the survey from before and after the pilot study are shown in Figures 18 and 19.

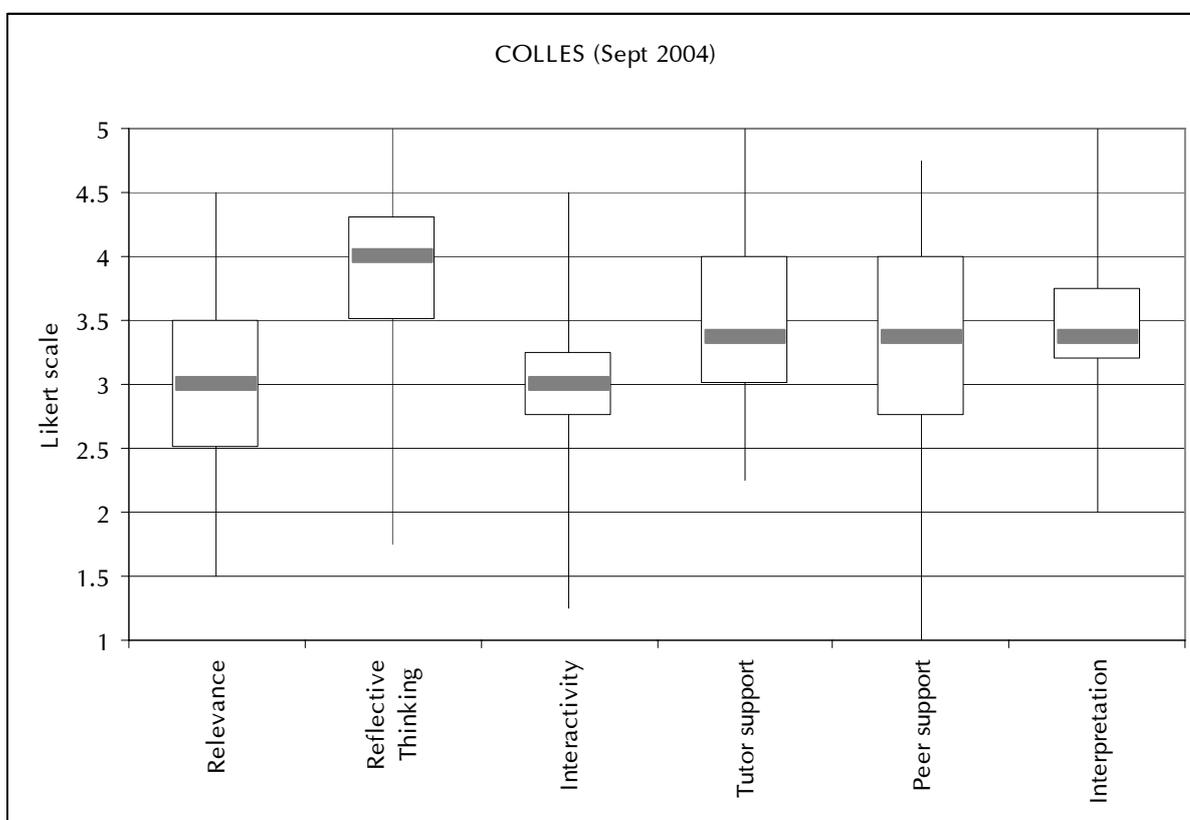


Figure 18 Box-Whisker plot showing results from simplified language COLLES at beginning of pilot study

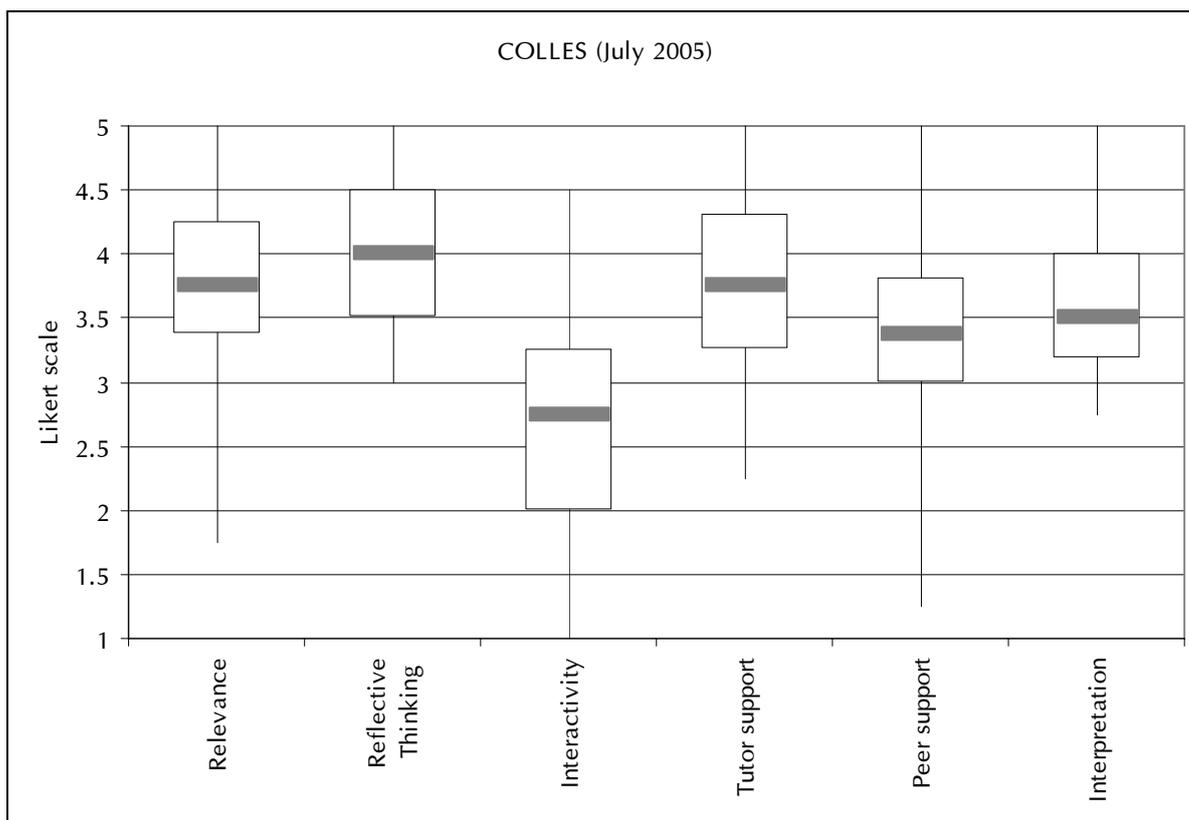


Figure 19 Box-Whisker plot showing results from simplified language COLLES at conclusion of pilot study

Aggregated across all 24 statements, there was a significant improvement over the course of the year ($P=3\%$), with a particularly significant gain on the relevance measure ($P<1\%$), perhaps because the use of a computer for homework meant that these tasks *seemed* more relevant to pupils' lives outside of school. Several individual statements also showed significant improvements over the course of the pilot: I have found the work interesting ($P<1\%$), when we start a topic, we talk about things in the real world ($P=2\%$), the things I learn help me to understand the world better ($P<1\%$), I learn how the things I'm taught will be useful for me when I leave school ($P<1\%$), the teacher makes me think ($P=2\%$), the teacher shows me how to discuss ideas ($P=1\%$), the other pupils encourage me to join in ($P=2\%$), and other pupils make good sense of what I say ($P=3\%$).

One statement showed a significant decrease over the course of the study, "I ask other pupils to explain their ideas" ($P=1\%$), although there was little evidence in the class

room or from the discussion logs that this had actually become less frequent over the year, and the VLE may perhaps have raised pupils' expectations in this area. Indeed the interactivity measure as a whole decreased over the course of the year, although not significantly so. Taylor and Maor (2000), obtained similar anomalous results on this measure in their original use of the survey instrument. Comparisons with the COLLES results from Taylor and Maor's original MSc students (*ibid*), indicate significantly less frequent use of constructivist learning here, particularly on the relevance (P=2%), peer support (P<1%) and interpretation measures (P=4%); simply introducing a VLE is unlikely to transform primary education into an experience directly comparable with postgraduate study.

In the absence of control data from earlier cohorts, it is impossible to identify the extent to which the introduction of the VLE has improved pupils' approaches and attitudes in these dimensions over and above the progress that would have occurred during the normal course of a year's lessons, however when placed alongside data from discussion forums and other forms of pupil feedback there does seem evidence that pupils' approaches to the subject have moved closer to a social constructivist ideal through the use of the VLE to extend a collaborative approach to learning from the classroom into the home. Although there was no overall correlation between VLE usage and improvement on these measures, use of the one to one message module did correlate with an overall improvement (P<1%), and with improvements on the relevance measure (P<1%), reflection (P=2%), interactivity (P<1%) and on tutor support (P<1%). Use of the journal module was linked to improvements on the interpretation measure (P=3%) and use of the chat module correlated with an improvement on reflection (P=5%).

Qualitative analysis of discussion threads revealed the emergence of recurrent themes in this aspect of VLE usage. Pupils felt comfortable using the discussion forums provided,

and adopted an informal, almost conversational style from the beginning, with SMS-style abbreviations replacing more conventional prose, to the disappointment of English teaching colleagues; a number of posts were also focussed on establishing social presence within the environment, such as this posting from the first evening's use:

“hi every 1 is the homework ok for you its so cool this stuff you no the internet By the way r you wearing summer or winter?”(sic, Year 6, B set).

The social presence dimension continued through the year, with occasional congratulatory posts on netball successes, and a cluster of posts wishing others luck in entrance papers.

Many discussion threads would focus on particular questions from the evening's homework questions, typically beginning with a query as to how to solve a problem, followed by a few posts of a “I can't do it either” nature, before another participant would post a hint of some form, rather than a full solution. The asynchronous nature of the discussion forum meant that a pupil might post a query early on in the evening, and then come back later to check if there had been any response, perhaps encouraging more reflection on the work. The following discussion is not untypical.

“Pupil 1 (16:51): hey
im realy stuck on hw...on the last 2 questions and....the one about fish
pie!!!!!! plz help me sum1!!!!!!!
[signed] ☺
Pupil 2 (18:46): Don't worry [name] I'M STUCK ON PRACTICALLY ALL OF
THE Q'S.
[signed] XOX ☺

Pupil 3 (18:57): Same [name], sorry i can't help. Although i am not sure but i think in the ratio questions u do 2:3 then 1:1.5 , 10:15 and so on. Sorry again!

[signed] ☹ ☹

Teacher (19:21): Right,

Q2 was a mistake on the mark scheme (oops) @'.@

Q5, use all the red paint, but only some of the blue.

Q6:Safari Park Zoo

10 3

130 ?

Pupil 1 (20:41): hello

thanks but i still dont get Q5!! it is really confusing me!!

[signed] ☺”

The above comment concerning a mistake on the mark scheme was not, alas, the only such. As all quiz content for the VLE had to be created directly, a number of mistakes were present in the posted quizzes. Pupils would generally spot these fairly rapidly and became accustomed to posting reference to these in the discussion forum, generally accompanied by an explanation of why the answer was what they thought. The author would, of course, immediately rectify these errors and re-grade earlier quiz attempts, but the explanations offered by pupils for why they deserved credit provided very clear evidence of their mathematical thinking, and furthermore showed their trust in their own understanding rather than the computer's response:

“It is telling me that the probability of chosing a vowel is not 4/9. This is not right. There are 4 vowels out of 9 letters so the probability of chosing a vowel IS 4/9 !!!!” (Year 6, Set B).

Particularly pleasing were the relatively rare posts in which pupils would instigate mathematical conversations. Some of these related to relevant television programmes or interesting websites, indicative of a degree of autonomy and a wish to share such discoveries with the other members of the learning community. Others were more remarkable still:

“I think I've worked out the age one by using algebra. So lets say their names are Meridith, Grandma and Sally to make it easier to cope other wise you have to different s's. So $M + S + G = 119$ (you have to scroll down to see all of it)

$2s = G, M = s/2$

$s/2 + S + 2s = 119$ therefore

$3 \frac{1}{2} s = 119$

so $s = 119 / 3.5 = 34$

so.... $S = 34$

$G = 68$

and $M = 17$

Is this right Mr Berry and is there an easier way? also could I do this with the money one?” (Year 6, set A)

By posting this in an open discussion forum, there seemed some likelihood that other members of the class could learn from this too, and it seems likely that the quality of mathematical discussion inside the classroom rose as a result of the conversations happening inside the VLE.

Another particularly encouraging observation from the discussion archive was the extent to which pupils that were seen as relatively shy in class displayed no such reticence in

contributing to online discussions, and a number seem to have been thus encouraged to contribute more fully to classroom discussions.

Relatively few pupils took up the opportunity to make regular use of the VLE's journal tool, but those who did appeared to find this a helpful mechanism for reflecting on each week's study. Similarly log files suggested that a number of pupils would look back over earlier quiz attempts and other resources, further reinforcing prior learning. Evaluations encouraged further opportunity for reflection, and again indicated much enthusiasm for both the VLE and the mathematics curriculum supported through it:

"This has been a great year for maths. I loved moodle." (Year 6, A group)

"I like the idea of homework on the computer and homework disscusen when your stuck." (Year 5, B group)

Use of the VLE also resulted in an improvement in pupils' computing and typing skills, alongside their mathematical development. Furthermore, as the VLE used is open source software, the pupils gained some awareness of the processes involved in software development, and were delighted when their ideas for new features, or their occasional bug reports, made it into a new release.

Although the VLE presented an unashamedly social pedagogy, its use during the pilot study also did much to promote learner independence and autonomy. On the occasions when differentiated homework has been set, the pupils had the opportunity to select from the range of activities available, and lesson introductions or notes recorded for one set were made available to all. Similarly, whilst the homework 'quizzes' were mandatory, other resources and activities were left for learners to select for themselves, and log files indicated a number of pupils choosing to explore aspects of the subject further through this means, again promoting their sense of responsibility for their learning.

With such diverse evidence supporting, if not necessarily proving, a view that the introduction of the VLE resulted in an improvement in pupils' approaches to their studies, particularly in regard to the social construction of understanding, responsibility for their own learning, perceived relevance, reflection and mutual support, it was hoped that there would be a corresponding improvement in attainment, even as measured by narrow spectrum testing regimes. Evidence for this formed the focus of the third part of the study.

Pupil Attainment

Internal evidence from the quiz module reports indicated that pupils were certainly making use of the feedback produced by the computer and the opportunity to re-attempt quizzes, with, unsurprisingly, final stored scores being higher than those obtained on first attempts. Comparisons with the corresponding homework scores from the previous cohorts indicated that final scores were significantly higher ($P < 1\%$), although the scores on first attempts were somewhat lower than those from paper-based homeworks, probably because pupils knew that they could have further goes and thus were not so concerned to get things right first time. Many pupils would also leave harder questions out on the first attempt, coming back to these once they were sure they had got the easier questions correct.

The pilot study was conducted at an independent school that does not formally participate in the National Curriculum Tests (SATs), thus these papers are marked internally, although rigorous procedures are observed to ensure that tests results remain comparable to those of other schools. The year 6 cohort that took part in the pilot study obtained the school's best ever SATs results in mathematics (see Figure 20), with 81% achieving level 5 or above, and 11% being objectively assessed at level 6, using the now discontinued extension paper from the 2002 tests. The subsequent cohort, who had been

in Year 5 during the pilot study documented here, and who continued to use the VLE in Year 6, performed almost as well in the 2006 tests, with 76% scoring at level 5 or above, and 12% achieving level 6. In neither cohort did any pupil score below level 4. Year 6 pupils taking entrance and scholarship exams in January during the pilot study performed at least as well as expected, with all securing places at their chosen schools; two major academic scholarships and a mathematics exhibition were won.

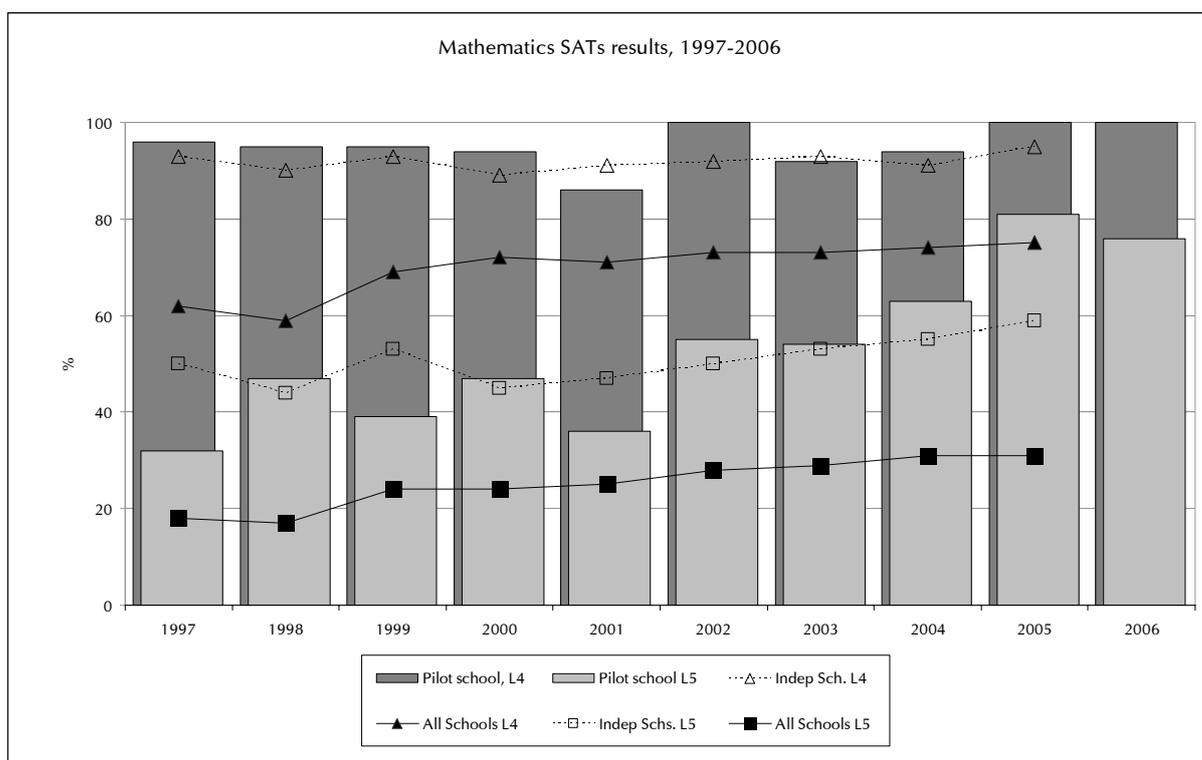


Figure 20 SATs results in Mathematics, 1997-2006

Although at first glance these results suggest a positive effect on pupil attainment from the introduction of the VLE, they do not take account of the prior attainment of the class, who might perhaps have been a particularly bright cohort, and thus such gains may be explained through other factors unrelated to the introduction of the VLE.

Apart from the introduction of the VLE, other aspects of the course remained largely unchanged from that provided to the two previous cohorts, and thus the relative progress of the pilot groups can be compared to that of previous groups. One straightforward way

of measuring this progress is through the use of standardised scores obtained from QCA and National Curriculum tests (SATs), see Figures 21 and 22. As these data are standardised scores, and thus make allowance for differences in pupil ages, it is possible to combine Year 5 and Year 6 scores on a single chart, perhaps more clearly illustrating the effect of introducing the VLE on pupil progress in the pilot study, see Figure 23.

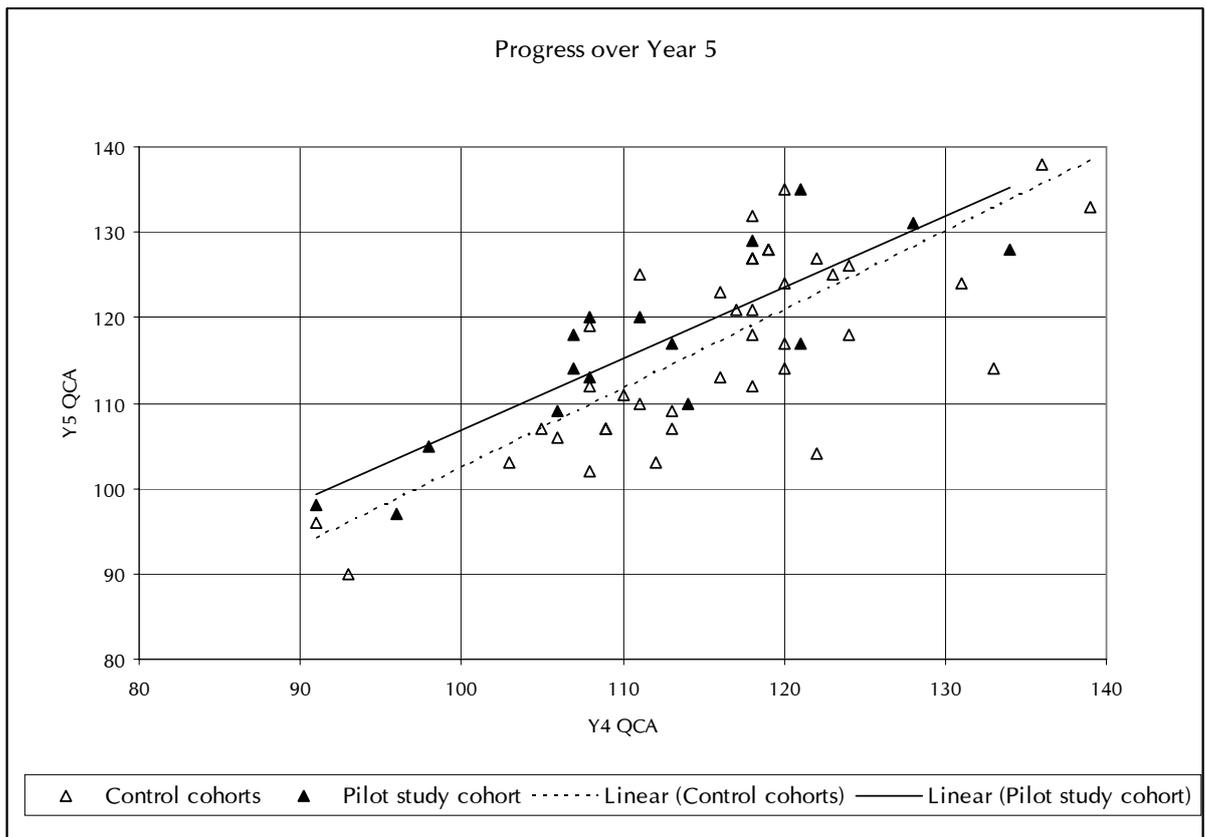


Figure 21 Scatterplot of progress over Year 5, pilot cohort and two previous groups

Linear modelling of the Year 5 data suggested that the introduction of the VLE had a negligible effect on test outcomes, and was not statistically significant.

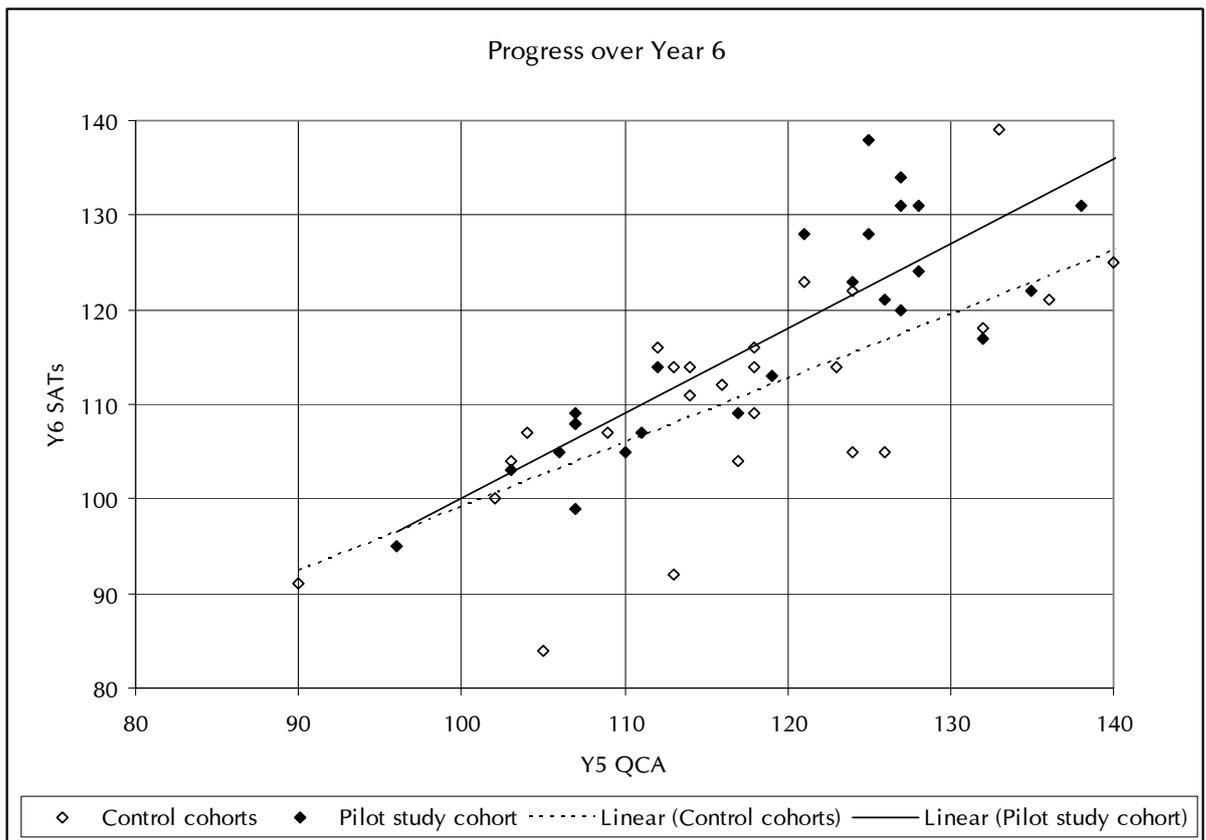


Figure 22 Scatterplot of progress over Year 6, pilot cohort and two previous groups

Fitting a linear model of the form $\text{post} \sim \text{pre} + \text{vle}$ to the Year 6 data suggests that introducing the VLE had produced a statistically significant 2.7 point increase in standardized scores ($P < 1\%$). From the above plot it is evident that the greatest benefit was obtained for pupils in the upper part of the ability range.

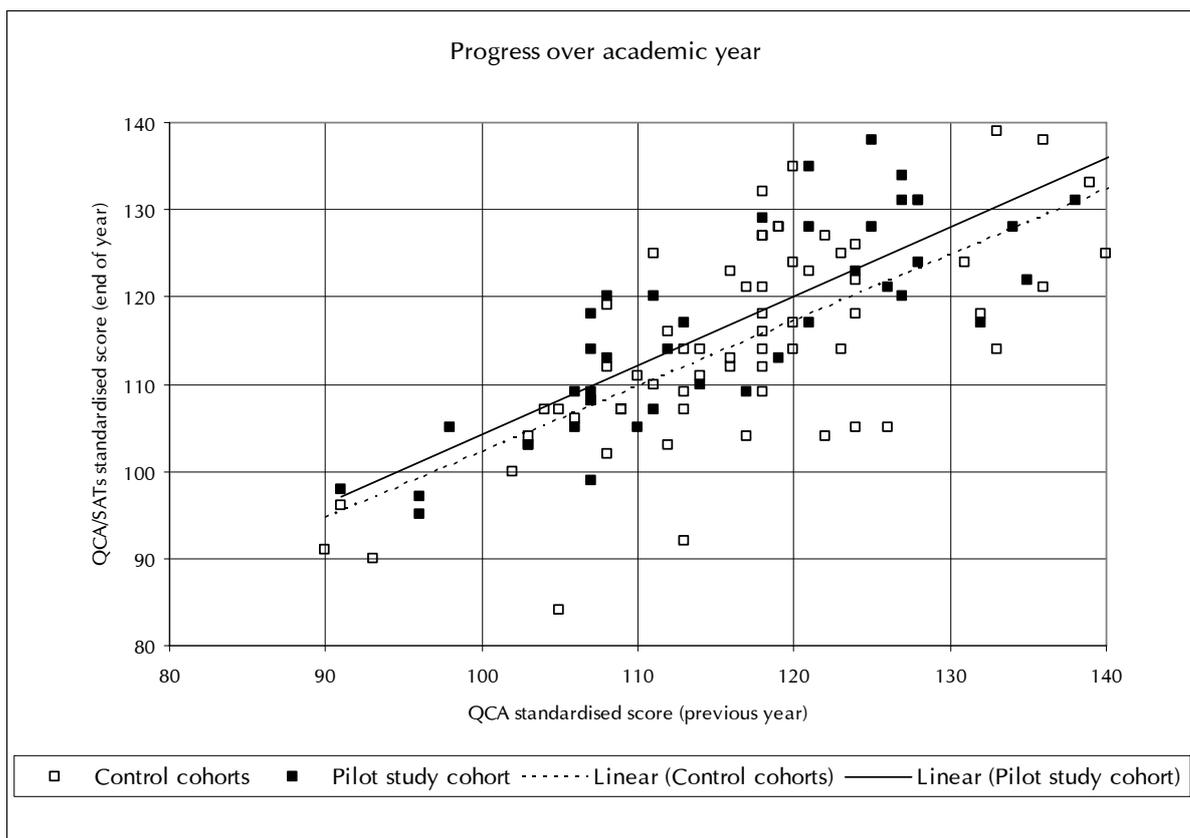


Figure 23 Scatterplot of progress over academic year, pilot cohort and two previous groups
(combined plot of Year 5 and Year 6 classes)

A linear model of the form $\text{post} \sim \text{pre} + \text{vle}$ applied to the aggregated data set indicates that introducing the VLE increased standardized scores by just 1.4 points overall, which is not statistically significant ($P=8\%$). The variability of the data is, of course, not fully explained by such a model, and the resulting residuals of individual scores above and below the trend line were worth exploring further. Modifying the model to take account of each pupil’s amount of VLE usage, rather than merely the opportunity to access the system if so desired, did not significantly improve the fit of the model, suggesting that there were other factors unrelated to VLE use which accounted for some pupils making greater progress than others over the course of the year. Further investigation of pupils’ *residual* progress measures showed correlation with a small number of the VLE modules: saving and reviewing quiz attempts ($P=3\%$, $P=5\%$ respectively), calendar use

(used to access brief lesson plans, $P=3\%$), user reports (*ie* access to the individual's personal log of VLE activity, $P<1\%$), wiki viewing ($P<1\%$), views of previous chat sessions ($P=4\%$), adding message contacts ($P<1\%$), and user profile updating ($P=1\%$). Taking these correlates at face value suggests that those using the VLE in a more strategic way, capable of stepping back from the immediacy of homework attempts and current discussion threads to look back over earlier quizzes, their own use of the system, and completed wikis, received the greatest benefit, and that online social presence was also correlated with successful use of the VLE. However, many of these functions were relatively rarely used, and so the above correlations may simply be indirect measurement of a greater technical competency and confidence resulting in greater benefit from the online environment. This analysis is, however, illustrative of the potential power of data mining as a knowledge creation tool when used with detailed VLE log files and assessment data.

There were no significant correlations between changes in COLLES results and these progress residuals.

Whilst the overall effect on academic attainment that appears to have followed from the introduction of the VLE is relatively small and does not appear statistically significant, this may in part be explained as an incompatibility between the assessment procedures adopted, *ie* individual, narrow spectrum testing focussed on recall and application to specific closed questions, and the more open, social, interactive style of learning that the VLE was designed to support. The development of assessment methodologies which could measure, and give credit for, progress in these dimensions, whilst beyond the scope of this study, would allow a more accurate measure of the impact of technology such as this to be obtained.

Conclusion

The study set out to address the extent to which VLE implementation in a primary school might be demonstrated as being effective, by addressing three inter-related research questions, and it seems appropriate to summarise the findings on each of these here.

Findings

Although the small size and self-selected nature of the sample in **the knowledge management survey** make it difficult to rely on the findings here, there did seem evidence to support the notion that VLEs, if their use is embedded in the culture of a school, have a great deal to offer to support the management of the school's knowledge and its organizational learning. Knowledge management seems little understood in schools, but where it is, better use seems to be made of the data held by the school (*qv* Kirkup *et al*, 2005).

At present, relatively little use seems to be made of VLEs as tools for codifying teacher's tacit knowledge, particularly for core management tasks such as planning and pupil performance tracking, although where this was happening, positive impacts were reported on organizational learning and knowledge management. More use is being made of these systems for sharing data, information and resources within the school, and this seems to lead naturally to a culture of greater collaboration within the school, and in some cases beyond, and again perceived impact on knowledge management and organizational learning.

A culture of collaborative working within the school seems essential to maximize the knowledge management benefits of a VLE, and this has important implications for organizational change management before, during and after implementing such systems.

Relatively little data analysis seems to be performed on VLE data (qv Kirkup et al 2005), perhaps due to poor linkage with MIS, and thus the impact of VLEs on decision making processes seems limited; interestingly the picture here seemed more positive for those using open source or other non-commercial systems; use of the former had increased significantly since Schoolnet's (2003) earlier survey, and participation in a VLE's development process did seem to result in respondents making more use of the tools provided. The introduction of a VLE can be a beneficial force for organizational change (qv Reyes 1997, p73), although the survey data suggested this was mainly confined to teaching and management, without the anticipated benefits on learning at pupil level.

Whilst VLEs have much to offer to schools as knowledge management tools, and potentially as transformative forces for learning and teaching, the survey data suggested these benefits were dependent on their use being embedded within the organization's culture, rather than simply being introduced as another technological innovation.

Although the pilot study was focussed on a single subject area for two year groups, rather than tackling the far more complex questions of embedding this technology in a school's culture, the findings from the mixed methods **analysis of pupil approaches** suggest that systems such as this can have a positive impact on pupil motivation and leaning habits, and thus school-wide implementation would be worthy of consideration. The blended approach of online access from home and face to face classroom interactions seemed to work well in primary education, and pupils responded to the VLE responsibly and enthusiastically, with the vast majority choosing to use it for homework, even though alternative provision was available.

Returning to the themes identified in the literature review (p24-31), use of wikis and some forum contributions suggested pupils were making good use of the VLE for shared

knowledge construction (qv Gibbs 1999), which was perhaps particularly apparent when several pupils worked together through the discussion forums to solve homework problems or to explain their reasoning. The very act of moving exercises to the computer seemed to create the impression of **realistic contexts**, as the COLLES data indicated. Furthermore, links to external websites and media, some provided by pupils themselves, provided some contact with the real world (Oliver & Herrington 2003).

By providing a range of resources and activities, and alternative homeworks, which pupils were free to choose from (qv Oliver & Herrington 2003), they developed a stronger sense of **ownership** of and responsibility for their learning (Land & Hannerfin 2000); this was particularly clear with the way in which many of the year 6 pupils had used the VLE to look back at earlier work and re-attempt quizzes, thus beginning to decide for themselves learning goals and strategies (Gibbs 1999). Pupils developed a stronger sense of **voice** through their use of the VLE, with even relatively shy pupils happy to contribute to online discussions (qv Hammond 1999), and a sense that they were explaining their thinking for an audience other than merely themselves or their teacher; there was evidence to suggest that pupils were becoming more confident in contributing thoughtfully to classroom discussions as well as their online counterparts, and many found the collective voice afforded through wiki activities inspiring (qv Esienstadt & Vincent 2000, p xii). COLLES results indicated a perception that pupils' contributions had been well understood by their peers.

The **social experience** of learning was certainly one that the VLE encouraged, and this perhaps was the greatest benefit, since the technology allowed the social dimension of learning that characterised classroom practice to be extended into the home environment, weaving together the experience of learning in the two environments. This was perhaps particularly apparent for pupils revising over the Christmas holiday, who

made good use of forums and the chat tool, but was also relevant to those absent from school, who could still feel part of the learning community. The sense of pupils helping one another, and taking shared responsibility for their peers' learning as well as their own was evident from some forum contributions, and the COLLES tracked improvement on "other pupils encourage me to join in". Particularly interesting in this regard was the level of social presence within the VLE that many of the pupils chose to maintain, through posts and messages of a social nature and maintenance of their profile pages.

Pupils became adept at accessing, and choosing between, a range of different media and activities (Land & Hannafin 2000), encouraging some greater awareness of multiple modes of representation. Greater learner **self awareness** seemed to follow from ownership and voice dimensions discussed above, but specific tools such as the underused journal module and the COLLES surveys encouraged more critical reflection on learning. Pupils became adept at learning from their mistakes using quiz feedback, several pupils would use quiz reports to provide a focus for revision activities, and pupils also used their own log record, rather than the course page, to look back over aspects of their learning, and revisit personally relevant resources and activities. Particularly interesting was the number of pupils who managed to assimilate an overall, holistic view of the course through use of the VLEs tools. Thus, there seems a body of evidence from the pilot study that the use of the VLE had promoted a change in pupils' attitudes and approaches, in ways that fully accorded with this understanding of social constructivist pedagogy.

Whilst it was encouraging that pupils made use of immediate feedback provided through online assessment to learn from mistakes and improve quiz scores, the findings in regard to the third research question, "**Does the implementation of a VLE have any**

significant impact on pupils' measurable academic performance?", might best be described as inconclusive. It is true that pupils performed well on entrance exams and for the SATs, and analysis of progress measures indicated a statistically significant, although small, improvement for the more mature Year 6 cohort, particularly at the upper end of the ability range, the aggregated data for both cohorts showed only a small, and statistically insignificant performance gain. The overall picture masks individual detail, with many pupils doing significantly better than might have been predicted, others rather worse; the application of data mining techniques suggested that the benefit was greatest where pupils had adopted a more strategic view of VLE usage, using tools to review the course as a whole and look back at earlier work, as well as maintaining a social presence within the environment, although use of these tools might simply be indicative of greater technical confidence. Given the focus of use here on the VLE as a tool to support social, collaborative and interactive learning, it is possible that there might have been significant gains in attainment which were however not measurable using a traditional form of testing: further work on assessment methodologies may be needed if VLEs are to be used to support this style of learning more generally.

Evidence of effectiveness here was regarded as sufficient for the author's school to move from pilot study into a phased introduction of the VLE to more subject areas and, importantly from a knowledge management perspective, as a tool for staffroom administration, communication and collaborative work (*qv* Minshull 2004, p28).

The author is conscious that this study is at a small scale and embedded in one particular context, however the results suggest that VLEs can contribute to school effectiveness through enhanced knowledge managements and improvements in pupils' approaches to their studies. They may also have some small impact on levels of pupil

attainment, although evidence here is inconclusive. Although the DfES rollout of Learning Platforms to all schools for 2008 (DfES 2005b, 2005c) has little underpinning in academic research, it is hoped that similar studies to this might be conducted elsewhere to provide a larger body of school based evidence around the use of these systems and their effectiveness, so that school leaders can make better informed choices concerning their use of this technology, and that the methodology used in this study is one which might be readily adaptable to other organizations.

Recommendations

Experience gleaned through the pilot study has proved invaluable in seeking to address the fourth research question listed in the introduction above, both for the author's own school and elsewhere, "what can school management do to ensure the maximum effectiveness of VLE implementation?"

Minshull argues that,

"It is ... essential that the selection of the VLE and the way it is implemented are in close accordance with the institution's strategic plan" (2004, p20)

Although the technical burden of VLE administration will be lessened for schools using a Local Authority or RBC provided Learning Platform, and this may be of particular benefit to primary schools (Gill & Shaw 2004, p7), the choice of VLE is an important one, as such systems are not pedagogically or epistemologically neutral, and one size certainly does not fit all. It seems important that a school choose a VLE which will support, and perhaps even help to develop or enhance, its collective vision for learning and teaching. A school that favours a highly individualised approach here, with the allocation of tailored tasks to each pupil, either by teachers or automatically, may prefer a very different type of VLE to a school committed to a social constructivist approach in

which learners need flexible communication and collaboration tools to allow shared knowledge building, as indeed would a school placing a premium on learner autonomy:

“The very systems that are meant to increase our information processing capabilities, thereby increasing understanding, may have the opposite effect by restricting the range of our inquiry and experience, effectively putting us in a kind of epistemological box.” (Pentland 2003, p550)

The total cost of ownership of a solution needs to be carefully evaluated, and assessed against the corresponding benefits (*qv* Becta 2005a). For many schools, aggregated purchasing through their local authority or RBC may prove most cost effective (DfES 2005c, Stolberg 2006), others may perceive greater benefits from commercially hosted solutions, or have sufficient in-house technical expertise to host an open source application like Moodle themselves, which has the additional advantage of being adaptable to fit more closely to a school’s specific requirements.

Important as such technical questions are, the knowledge management survey above suggested that the most important factor in effective implementation will be the establishment of a culture of collaboration amongst a school’s staff. Many VLE systems, particularly those that can be used to support social constructivist pedagogies, are likely to provide tools which can also be used to facilitate such collaboration, and many schools, perhaps particularly in the primary phase, already have such a culture.

Collaboration between schools is also likely to be of value, as a means of wider knowledge sharing and validation, but also to reduce the workload in creating and or supporting online courses. Facilitating resource sharing between teachers is crucial to the promotion of effective knowledge management in schools, in a way in which the delivery of pre-packaged, commercial content is not. LA and RBC wide implementations have much to offer in this area, and the international, cross-phase community that has

developed around Moodle, itself a product of collaboration beyond institutional boundaries, provides another model. Opportunities for international collaboration, at pupil, teacher or school level, are readily facilitated through VLE systems (Inglis *et al* 2002, *qv* Friedman 2005). Peer collaboration and sharing ideas and practice via online networks is envisioned by the DfES (2005a, p32), and, of course, VLEs themselves can provide the rich blend of tools to support CPD through a distributed community of practice, as the author has argued elsewhere (Berry & Partridge, 2006).

The quantity of pupil level data available in a fully populated and well used VLE can readily provide opportunities for pupil level interventions and knowledge creation through the application of data mining techniques. However, to fully benefit from this potential, it would be necessary for a school's various information and knowledge systems to be integrated, and for the use of these systems to be properly embedded within the school's culture (Visscher & Wild 1997, p270).

Embedding systems like these within the school's culture is non-trivial, but does seem to offer the greatest benefit for knowledge management, organizational learning, and impact on teaching and learning, and ensures their sustainability over personnel changes. Involving all of a school's stakeholders, particularly pupils, parents, teachers, administrative and technical staff in this process will be of importance. Well thought through technical issues, establishing a culture of collaboration within and beyond the institution, and use of the systems to inform day to day and strategic decisions will help, but the keys to achieving fully embedded systems seem likely to be leadership vision (Visscher & Wild 1997, p270) and the up-front change management skills (Reyes, 1997, p74) necessary to move large and diverse organizations forward in this, one step at a time (Darby 2002, p25).

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Appendix I
Survey of VLE users in UK schools
to investigate use for knowledge management

(Some questions are drawn from the Schoolnet survey (EUN2003))

The final appearance of the survey differed from that shown below as the questionnaire was administered via the World Wide Web. The survey was live between 7/2/2005 and 17/3/2005. A total of 33 responses were received.

By Virtual learning environment, we mean an electronic system that can provide online interactions of various kinds that can take place between learners and teachers, including online learning

Please be assured that your responses will be treated confidentially; neither you nor your school will be identified in the report based on this survey.

If you have any queries about this survey, please contact me at mb156@leicester.ac.uk

Thank you for taking the time to respond to these questions.

A Background information

In which school do you work?

[Respondents wishing to remain anonymous may leave some or all of these fields blank]

Name: *26 supplied, 7 anonymous*

School: *26 supplied, 7 anonymous*

Address:

Town:

Postcode:

LEA:

Country: *30 UK, 2 USA, 1 Kuwait*

Website URL: *22 supplied, 11 not given*

Email address: *27 supplied, 6 not given*

At what level do you teach / work?

Primary [6]

Middle []:

Secondary [20]

Other (please specify) [*FE 2, HE 3, LA 2*]

In which sector do you work?

Maintained [20]

Special school []

City Technology College [2]

Independent [8]

Other [3 - *HE*]

Do you have experience of a VLE as [*NB multiple options possible*]

Teacher [16]

Headteacher / deputy headteacher [3]

ICT coordinator [17]

ICT adviser / consultant [10]

Administrator [14]

Other (please specify) [5]

For the following questions, would you prefer to answer in relation to your own teaching or the overall work of your school?

My own teaching [10]

The overall use in my school [23]

What kind of VLE are you using?

A commercial VLE [14]

An open source VLE product [11]

An in-house VLE (developed within your institution, LEA, RBC *etc.*) [8]

Have you participated in its development? 17 Yes/ 16 No

Which VLE are you using?

Name: 7 Moodle, 4 Blackboard, 2 e-sy.info, 2 Fronter, 2 Granada, 2 Microsoft, 2

Tapped In, 15 others

URL:

B. VLE tools

Which of these typical VLE functions do you use, within the VLE itself:

Tool

Extent of use

Tool not Never Occasionally Frequently Don't

	available			know	
Communication tools					
External E-mail	[11]	[4]	[6]	[11]	[1]
Community E-mail	[7]	[2]	[11]	[11]	[2]
Mailing lists	[10]	[9]	[8]	[4]	[2]
Notice board	[0]	[2]	[6]	[25]	[0]
Student homepages	[8]	[7]	[6]	[8]	[4]
Synchronous collaboration tools					
Chat	[8]	[9]	[12]	[3]	[1]
Instant messaging	[10]	[10]	[4]	[6]	[3]
Shared whiteboard	[14]	[7]	[4]	[4]	[4]
Group browsing	[11]	[5]	[6]	[4]	[7]
Voice over Internet Protocol	[19]	[8]	[2]	[2]	[2]
Asynchronous collaboration tools					
Forums	[2]	[1]	[16]	[14]	[0]
File uploading	[0]	[1]	[2]	[29]	[1]
Peer to peer sharing	[11]	[6]	[6]	[5]	[5]
Link lists	[1]	[2]	[8]	[15]	[7]
Shared glossaries	[8]	[5]	[8]	[6]	[6]
Wiki	[14]	[7]	[4]	[0]	[8]

Other tools

Resource storage	[2]	[1]	[8]	[20]	[2]
Possibility to assign tasks to students	[3]	[2]	[6]	[19]	[3]
Shared calendars	[4]	[7]	[6]	[14]	[2]
Tools to create online resources	[4]	[1]	[5]	[21]	[2]
Tools to create online courses	[3]	[2]	[10]	[17]	[1]
Assessment tools for learning progress	[4]	[3]	[10]	[12]	[4]
Automatic generation of metadata for learning resources	[6]	[5]	[6]	[4]	[12]
Online surveys	[3]	[7]	[14]	[7]	[2]

Additional tools (please specify)

Competency based assessment, learning log, support for multimedia resources, website content management.

C VLE use for Knowledge Management

Knowledge management activities are those that an organization undertakes to harness its intellectual capital, by which the organization comes to learn to know what it knows.

Please consider the following statements either for your own work or for that of your organization as you indicated in section A above, in the former case, please replace “our” with “my” *etc.* in the following statements. Please choose the option to indicate the extent of your agreement. If you wish to make comments on any of these statements, please do so in the space provided

	Strongly disagree	Disagree	No opinion	Agree	Strongly agree	Comments
Our VLE is used for lesson planning	[5]	[5]	[7]	[11]	[3]	
Our VLE brings together the online resources that our pupils need	[3]	[1]	[6]	[9]	[13]	
Our pupil assessment data is held in our VLE	[6]	[6]	[10]	[6]	[4]	
Our VLE is used for pupil – teacher dialogue	[3]	[4]	[6]	[13]	[5]	
Other teachers can access data a teacher adds to the VLE	[3]	[6]	[1]	[12]	[9]	
Senior Management can access the data a teacher adds to the VLE	[3]	[2]	[5]	[11]	[10]	
We use our VLE to share information amongst	[4]	[5]	[4]	[10]	[9]	

teachers

We use our VLE to share [3] [5] [3] [10] [11]

resources amongst teachers

We use our VLE to share [8] [8] [8] [5] [3]

information with other

schools

Our staff use the VLE to [3] [5] [6] [13] [4]

work collaboratively with

each other

Our VLE is used to work [7] [10] [7] [5] [2]

collaboratively with other

schools

We regularly analyse data [5] [8] [7] [9] [2]

from the VLE.

We look for trends and [6] [7] [11] [4] [3]

exceptions within the data

in our VLE

Use of the VLE has allowed [5] [3] [11] [8] [4]

us to make better informed

management decisions

Use of the VLE has allowed [2] [3] [10] [11] [4]

us to make better informed

decisions about pupil

support

Our VLE is fully integrated [9] [8] [3] [6] [5]

with our Management

Information System (MIS).

Our VLE has had more [2] [4] [12] [5] [8]
 impact on the quality of
 teaching and learning than
 our MIS has.

We've changed the way we [1] [7] [6] [15] [3]
 teach because of the VLE.

We've modified the VLE to [1] [8] [5] [15] [3]
 fit in with the way we teach.

Our VLE has resulted in [3] [2] [10] [13] [4]
 better management of the
 knowledge we have.

Our VLE has promoted [3] [1] [11] [10] [6]
 better organizational
 learning (or development).

Our VLE has promoted [2] [1] [17] [9] [3]
 pupils' construction of
 knowledge.

Our school has a knowledge [10] [6] [11] [2] [4]
 management policy

Most of a teacher's [5] [7] [9] [7] [5]
 knowledge about what they
 teach is locked in their
 heads

Most of a teacher's [6] [7] [7] [9] [4]
 knowledge about their
 pupils is locked in their
 heads

Any further comments?
[12 additional comments received]

D. The contribution of the VLE to learning

Again please indicate the extent of your agreement:

	Strongly disagree	Disagree	No opinion	Agree	Strongly agree	Comments
Our VLE has improved the way teachers approach their lessons	[6]	[6]	[14]	[5]	[1]	
Our VLE has improved the way pupils approach their lessons	[6]	[4]	[15]	[5]	[2]	
Our VLE has raised the level of pupil attainment	[3]	[16]	[6]	[3]	[3]	

Have you or your school obtained any evidence in relation to these three areas? If so, please describe:

[10 additional responses received]

E. And finally...

Would you like to receive a summary of the study's findings? [25] Yes / [8] No

Would you be willing to be contacted by me to take part in further research in this area?

[21] Yes / [12] No

(If you have answered yes to either of the above, please ensure your email address is given in section A)

Thank you very much for taking the time to answer this survey.

Appendix 2

VLE Selection

Although a detailed discussion of the VLE selection process is beyond the scope of this study, the selection of a particular VLE is a key management decision; both JISC (2003b) and FERL (Becta, 2004c) have advice to offer to the post-16 sector, Gill & Shaw (2004) have sought to address this issue for schools, and the DfES (2005c) seem eager that provision be aggregated through Local Authorities (LAs) or Regional Broadband Consortia (RBCs). Once a functional specification of the environment was drawn up, the comparison table at www.edutools.info/course/compare/byfeatures/index.jsp identified a shortlist of VLEs, with more detailed investigation leading to an eventual choice for the pilot investigation. For the purpose of this study, it was important that the chosen VLE: would incorporate the features typical of VLEs in general; be compatible with a social constructivist approach (*qv* Land & Hannafin 2000, p11); be accessible to primary aged pupils; require no additional hardware; and could itself be funded from existing budgets. An even more thorough selection process with perhaps a relaxation in some of the above conditions would be appropriate for a whole school implementation (Minshull 2004, p3, DfES 2006).

This process resulted in the eventual selection of Moodle (see www.moodle.org) as the VLE for the pilot study, and this has been installed on the school's external webserver, and subsequently moved to an in-house server at www.stiveshaslemere.net/moodle (password required). In addition to the above criteria, Moodle has the advantages of a clear social constructivist rationale (Dougiamas & Taylor 2003), and of being open source (and hence freely licensed and user adaptable) software (Raymond 1999). The author's school has a long and successful experience of open source software (Smedley 2001) and

thus had already addressed Minshull's (2004, p22-23) warnings over this development model.

Involvement in open source development addresses under utilization of VLE provision (EUN 2003, Gill & Shaw 2004), since in open source development, where teachers can be involved in the development process, "the software evolves to embody the values of the user community" (Dougiamas & Taylor 2003, p8), and teachers' specific needs can be addressed (*cf* Gill & Shaw 2004, p3, Fung & Visscher 2001, p83). Tatnall and Davey (2001) argue that school management

"Software should empower... an individual school by enabling it to make appropriate changes in the way the software operates" (p66, *qv* Visscher & Wild 1997, p271, Wild *et al* 2001),

whereas in contrast,

"the cost structure of the products of the major commercial [VLE] suppliers tend to encourage central provision of VLE and, it is argued, a degree of inflexibility in delivery" (Konrad 2003).

Additionally, open source software development strategies such as releasing early and often and user community involvement fit closely with the participatory action research model adopted for the case study, and with the reflective 'tinkering' that Hargreaves (1999, *qv* OECD 2000, p72) sees as crucial for knowledge creation in schools. Moodle's designers:

"Iteratively: (i) apply theory to software design; (ii) put design into practice; (iii) collect and analyse data; and then (iv) use the results to revise our theoretical perspective before embarking on the next study cycle. The results of this approach are evolving theory and evolving software." (Dougiamas & Taylor 2003, *cf* Dougiamas & Taylor 2002).

Appendix 3
Modified COLLES Questions used for survey of pupil perceptions and attitudes.

(Pupils respond on a five point Likert scale, “Almost never”, “Occasionally”, “Sometimes”, “Often”, “Almost always”)

Moodle standard COLLES

Child friendly version

My learning focuses on issues that interest me

I find the work interesting

What I learn is important for my professional practice

When we start a topic, we talk about things in the real world

I learn how to improve my professional practice

The things I learn help me to understand the world better

What I learn connects well with my professional practice.

I learn how the things I’m taught will be useful for me when I leave school

I think critically about how I learn

I learn how to learn

I think critically about my own ideas

I think through my own ideas

I think critically about other students’ ideas

I think about what other pupils say

I think critically about ideas in the units

I really try to understand the things we’re taught.

I explain my ideas to other students

I explain my ideas to other pupils

I ask other students to explain their ideas

I ask other pupils to explain their ideas

Other students ask me to explain my ideas

Other pupils ask me to explain my ideas

Other students respond to my ideas

Other pupils respond to my ideas

The tutor stimulates my thinking	The teacher makes me think
The tutor encourages me to participate	The teacher gets me to join in
The tutor models good discourse	The teacher shows me how to discuss ideas
The tutor models good self-reflection	The teacher shows me how to think things through for myself
Other students encourage my participation	The other pupils encourage me to join in
Other students praise my contribution	The other pupils say nice things about what I say
Other students value my contribution	What I say helps the other pupils to learn
Other students empathise with my struggle to learn	The other pupils help me when I'm stuck.
I make good sense of other students' messages	I understand what other pupils say
Other students make good sense of my messages	Other pupils understand what I say
I make good sense of the tutor's messages	I understand what the teacher says
The tutor makes good sense of my messages	The teacher understands what I say
Do you have any other comments?	Do you have any other comments?

These changes lower the Flesch-Kincaid reading grade from 5.4 to 3.8.