

# Developing Virtual Server-Based Managed Learning Environments

*Kevin Brace, Carl A. Kennard, & Mark Walker*

*Harper Adams University College*

**2006**

[kbrace@harper-adams.ac.uk](mailto:kbrace@harper-adams.ac.uk)  
[ckennard@harper-adams.ac.uk](mailto:ckennard@harper-adams.ac.uk)  
[mwalker@harper-adams.ac.uk](mailto:mwalker@harper-adams.ac.uk)

## **Abstract**

This paper discusses the development of managed learning environments run on virtual servers. It charts Harper Adams University College's migration from WebCT to Moodle in 2006, combined with the addition of new video servers, the installation of Questionmark Perception, and linking the system to the University's SITS registry database. This required the formation of new working practices and the implementation of technology with the flexibility to create multiple servers with minimum effort.

The reasons for this migration, the proposed benefits, the virtual server technology, and the methodology behind its development are discussed. The project found virtual servers allowed the implementation of multiple instances of Moodle with speed and flexibility from a single computer via a simple GUI interface. Conclusions are drawn on the success of the project and its future development to provide a platform for delivering other educational software.

## **Introduction**

This paper explores the development of managed learning environments run on virtual servers, investigating the reasons for their implementation, and evaluating the effectiveness of their use. Harper Adams University College's development of a new pilot MLE is used as a case study.

A planned MLE implementation, begun in 2005, combining the institution's WebCT virtual learning environment (VLE) with a SITS registry system on the existing standard server provision had failed to advance beyond the early development phase, being further complicated by the late release of the Campus Edition 6.0 software upgrade, leading to an investigation into alternative options.

## **Managed Learning Environments**

Existing literature defines managed learning environments (MLEs), as the information systems and processes of a college or university (including its virtual learning environment) contributing directly, or indirectly, to learning and the management of learning (Joint Information Systems Committee). This results in "the integration of a range of different and evolving systems and components using common standards" (Holyfield, 2003, p.1).

MLEs link eLearning provision to administrative systems, such as finance and student registration (Becta, 2003, p.3) eliminating the disparate record system infrastructures, created by past "ad hoc" developments rife with information

replication (Allison, Bain, Ling, & Nicoll). This allows an institution's VLE to "join up" (Conole, 2002, p.6) with other systems, such as:

- Administrative course information
- Resources
- Student support
- Collaboration tools
- Assessment and feedback
- Evaluation (Conole, 2002, p.6)

Although MLEs can provide integrated infrastructures, existing literature maintains they should not be viewed as an all encompassing solution, being incapable of meeting all of a user's needs (Conole, 2002, p.10).

### Virtual Learning Environments

VLEs enable online interaction between teachers and students while making learning objects, course materials, and assessment tools available via the World Wide Web, (Becta, 2003, p.1) being central to MLE construction. These systems are widely applied in Higher Education, often providing access to distance learning courses (Becta, 2003, p.3).

Asynchronous learner communication via discussion groups and message boards is an important VLE attribute, enabling students to learn from their peers, (Alessi & Trollip, 2001, p.34) potentially increasing learner motivation, (Becta ICT Research) and giving learners the opportunity to reflect on their work (Nulden & Hardless). Reflection allows students to see how solutions can be used as a "tools" (Papert, 1980, p.76) applicable to a number of different contexts.

Critics of asynchronous communication believe it can leave the learner with a restricted view of wider course contexts, while the lack of face-to-face contact leads to lower attendance rates (Nulden & Hardless). Other authors suggest a combination of well designed activities and providing feedback via synchronous and asynchronous communication tools will help to emulate the traditional face-to-face interaction promoted by the conversational model (Laurillard, 1993).

VLEs transform the teacher's role from sage-on-the-stage behaviourist instructor to constructivist guide-by-the-side (Druin & Solomon, 1996, p.16). Constructivists believe people learn based on prior knowledge (Nulden & Hardless). The constructivist lead learner begins to develop related concepts and take greater control of their own learning (Christie, James, Vaughn, 1996), adopting greater ownership of the varied VLE resources (Haug, 2002). The teacher's responsibility is to deduce and "capitalise" (Druin & Solomon, 1996, p.16) on learners' personal educational strategies, (Druin & Solomon, 1996, p.16) offering negotiated pathways and increased autonomy, whilst providing support materials (Papert, 1980, p.31-32.). The promotion of learner autonomy can be further improved by incorporating a wide range of engaging resources and support mechanisms (Phillips, 1996) (often linked to the WWW) helping to guide the learning experience (Laurillard, 1993).

By assuming a manager role, teachers encourage learners to "look critically at their own work" (Schneider, Syneta, Fete, Giradin, & Morand, 2003) and discuss their progress with their peers. Functioning as an advisory facilitator, teachers provide support materials, enabling learner progression and offering help when obstacles become impossible to independently overcome (Schneider et al., 2003). Teachers initially employ "scaffolding," techniques (Nulden & Hardless) to offer the learner "contextual support," (Boyle) then gradually withdraw materials and assistance as students become more independent (Boyle). The supportive tiered framework

provided by the learning facilitator and VLE is best described by the five stage model (Salmon, 2002). Learners given an assignment without scaffolding provision may struggle during the early stages, stray off-task, or produce inadequate work (Schneider et al., 2003).

Teachers should avoid overloading learners with extensive systems, striking a balance between a variety of engaging tools, and pedagogies (Schneider et al., 2003) in an easily used environment they will be able to use effectively (Misrah, 2002). It is the learners who create a thriving community, not computer systems (Strohecker, 1994) and even the most technically advanced VLE can fail without their participation.

### Method

The development of Harper Adams University College's new MLE had five primary objectives:

- Develop a sustainable platform for the eventual migration of all the college's existing courses to a new VLE.
- Integrate the VLE with the college's registry system, to ensure centralisation of user data.
- Incorporate the TALIS list reading list software.
- Link the VLE with a learner centric portal, replacing the current intranet.
- Develop a scalable system with the scope for the future addition of further E-Learning tools.

### Moodle Migration

Following research into usability and system integration options, Moodle was chosen as the replacement for WebCT. Moodle is a SCORM compatible (Galmacci & Milito, 2005, p.4) course-management style VLE created by Martin Dougiamas, (Brandl, 2005, p.1) with roots in socio-constructivist pedagogy (Technical Advisory Service for Images, 2005, p.1). It contains both synchronous and asynchronous communication tools to encourage collaborative learning and the development of "communities of practice," (Dougiamas & Taylor, p.2) providing an alternative to increasingly expensive commercial software (Brandl, 2005, p.1). Moodle (Modular Object-Oriented Dynamic Learning Environment) is a free open source product which can be downloaded from the Internet, enabling financial costs to be reduced. Using open source software provides independence from commercial providers, the full, customisable source code being available to the wider community, (Ratschiller, 2000) allowing individual institutions to adapt software to their personal requirements (Cooke, 1999).

Moodle is able to act as scaffolding for classroom instruction, a blended learning course component, or a platform for online distance education (Brandl, 2005, p.2). The system is comprised of a number of activity modules to aid the lecturer, including chat rooms, discussion forums, wikis, assignments, multiple choice quizzes, and surveys (Galmacci & Milito, 2005, p.4). The modular structure of Moodle uses a "flat view format" (Brandl, 2005, p.2) organising the various screen elements into easily navigable blocks. The intuitive look and feel of the Moodle GUI compared to WebCT was a deciding factor in its initial selection. Moodle offered a traditional website feel, ensuring user affordances (Norman, 1988) of existing GUI's were maximised for the VLE, making the new system easier to learn (Neilsen, 1993).

To accommodate the course migration, the E-Learning team devised a method for using Moodle to provide access to all of the college's courses. After consideration, two options were identified:

- Creating a new instance of Moodle for each of Harpers Adams' academic groups.
- Using a single instance of Moodle as a lone access point for all courses.

The second option of a single instance of Moodle was chosen, based on the belief this would simplify the process, reduce the risk of unnecessary resource duplication, making it easier to administer and keep control of an increasingly expanding learning environment.

At this time (late 2005) a new online distance learning course was also being developed and in conjunction with the head of the course, it was determined this would be used as the pilot study for the new MLE, prior to the roll-out of the complete system the following academic year. Consequently, it was decided this would operate as a stand-alone course whilst the main MLE was being fully developed, requiring a second instance of Moodle. Initial tests were conducted on a Linux OS Pentium 4 web server, providing ample operational capability for early development.

### **Backend functionality and Server provision**

The decision to take a MLE approach expanded server requirements beyond their prior capacity and more extensive provision was required to accommodate the test bed Questionmark Version 4 Perception assessment tool, a streaming video server, the new content management system, and a third Moodle instance intended to be used as a sandpit for staff experimentation in isolation from the main VLE development. Continuing with the existing methodology required the purchase of new hardware and time spent physically installing new servers, the process being repeated each time a new component was added to the MLE; an inefficient working practice for coping with increasing scalability requirements.

After research, an alternative option was identified; Virtual servers, a rapidly maturing technology (Stanford & Chandrasekhar, 2005, p.1) allowing multiple operating systems to be employed on a single machine (Keahey, Doering, & Foster, p.4). Virtual machines incorporate the same benefits of separating physical servers into a hierarchy "while dramatically lowering the hardware and operational costs" (Rose, 2004, p.4) accrued by administering multiple physical devices (Rose, 2004, p.4).

A number of virtual server systems exist, such as VServer (Linux kernel-based servers using additional security contexts, new system calls, and management utilities (Keahey et al, p.4)) and VMware (maintaining a directory of VM configuration information and disk images (Keahey et al. p.5)). These provide scalability by "transparently adding or removing a node in the cluster" (Wensong, p.1) of servers supporting the MLE (Zhang, p.1). Of the available products VMware was chosen to provide the MLE platform, allowing individual IP addresses to be assigned to each virtual server (Rose, 2004, p.8) via its VirtualCentre software (Stanford & Chandrasekaran, 2005, p.1) providing the flexibility and scalability required by expanding infrastructures (Stanford & Chandrasekaran, 2005, p.1).

However, VMware is not without its faults, requiring repetition of time-consuming software installations for each virtual machine, (Keahey et al. p.6) while full virtualisation on PC architectures is extremely complex (Rose, 2004, p.10).

## **SITS integration**

The final stage of the project remit was the direct connection of the new VLE to the college's SITS registry system, a 200+ table, relational database containing all student and associated award data. Linking the systems would allow students to logon to the new VLE using their student registration ID and password rather than requiring a second set of authentication credentials, as with the existing WebCT installation. This would meet the project's aim to provide a single access point to the new VLE using single sign-on via a portal. Linking to the constantly updated SITS system avoids having to upload student details to the VLE a second time (manually uploading CSV files), as required by WebCT, significantly reducing administrative load.

## **Results**

The project found Moodle offered a viable alternative to commercial software. The system was easy to install and offered a wider range of E-Learning tools than the previous VLE. The ability to re-skin the interface using a custom theme also allowed branding to match the Harper Adams corporate colour scheme and logo, clearly identifying it as specific to the college, instead of the generic design of WebCT. The Moodle page layout closely resembles a standard web page, using a three column design familiar to web users, allowing previously formed mental maps of standard web GUIs to be applied to the VLE, improving usability (Norman, 1988).

Problems were encountered with establishing a logical file structure enabling learning materials to be made easily available without being lost within directories containing support files such as images and style sheets. This ensured the standard course/module structure was faithfully reproduced, enabling the VLE structure to be mapped onto existing teaching and learning models.

Integrating TALIS list into the institution's MLE proved to be a more ambitious enterprise than expected, requiring a longer installation and configuration phase than was initially envisaged. The link with TALIS list will be provided via a URL inside Moodle as a learning resource, each reading list having a unique URL, which in turn is linked to the library OPAC system.

## **Vmware development**

VMware successfully enabled the rapid creation of new servers, meeting the project's scalability requirements. Servers could be quickly created and monitored using a GUI interface, eliminating the need for further device installation. However, additional financial outlay was required, as the computer running the VMware had insufficient memory capacity. To ensure there was sufficient disk space available for these new applications, a new 0.5 Terrabyte raid array disk set was required, at a cost of £1,600.

New working practices for backing up the MLE had to be established. Problems with VMware rendered the Moodle system unusable for a week during development, requiring the restructuring of the whole VMware software and the saving of existing materials, a lengthy process, although when the front end GUI was rebuilt, the servers and data contained therein were found to be intact.

Connecting the VMware based VLE to SITS via LDAP, proved to be a significant step in the foundation of a functioning MLE for the pilot distance learning course. Single sign-in authentication through the institution's portal was established via lchain, allowing students accessing the VLE with their network password and

username, instead of having to use a second set of credentials, as with WebCT (see figure 1).

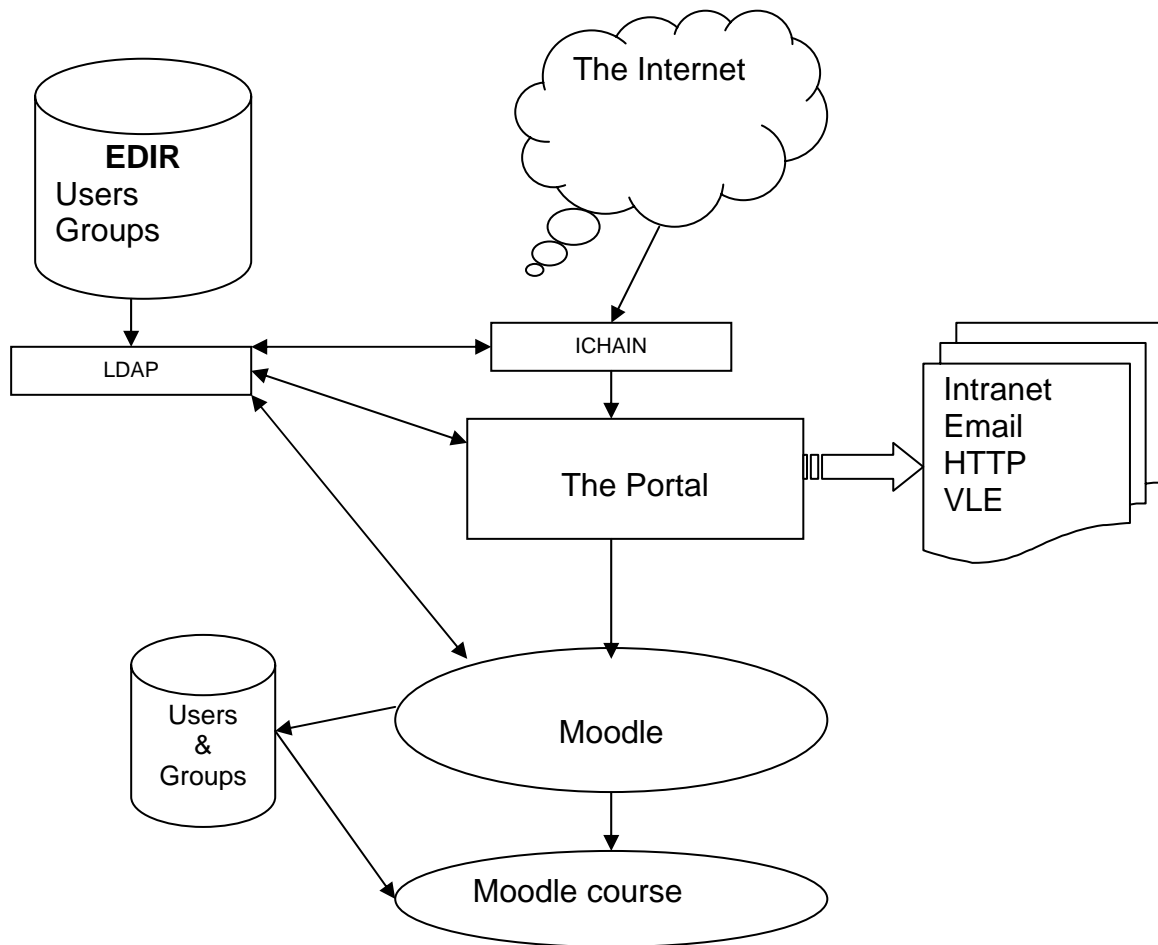


Figure 1 Current authentication method using Edirectory

This will be developed into a direct connection for the full institution wide migration, resembling figure 2.

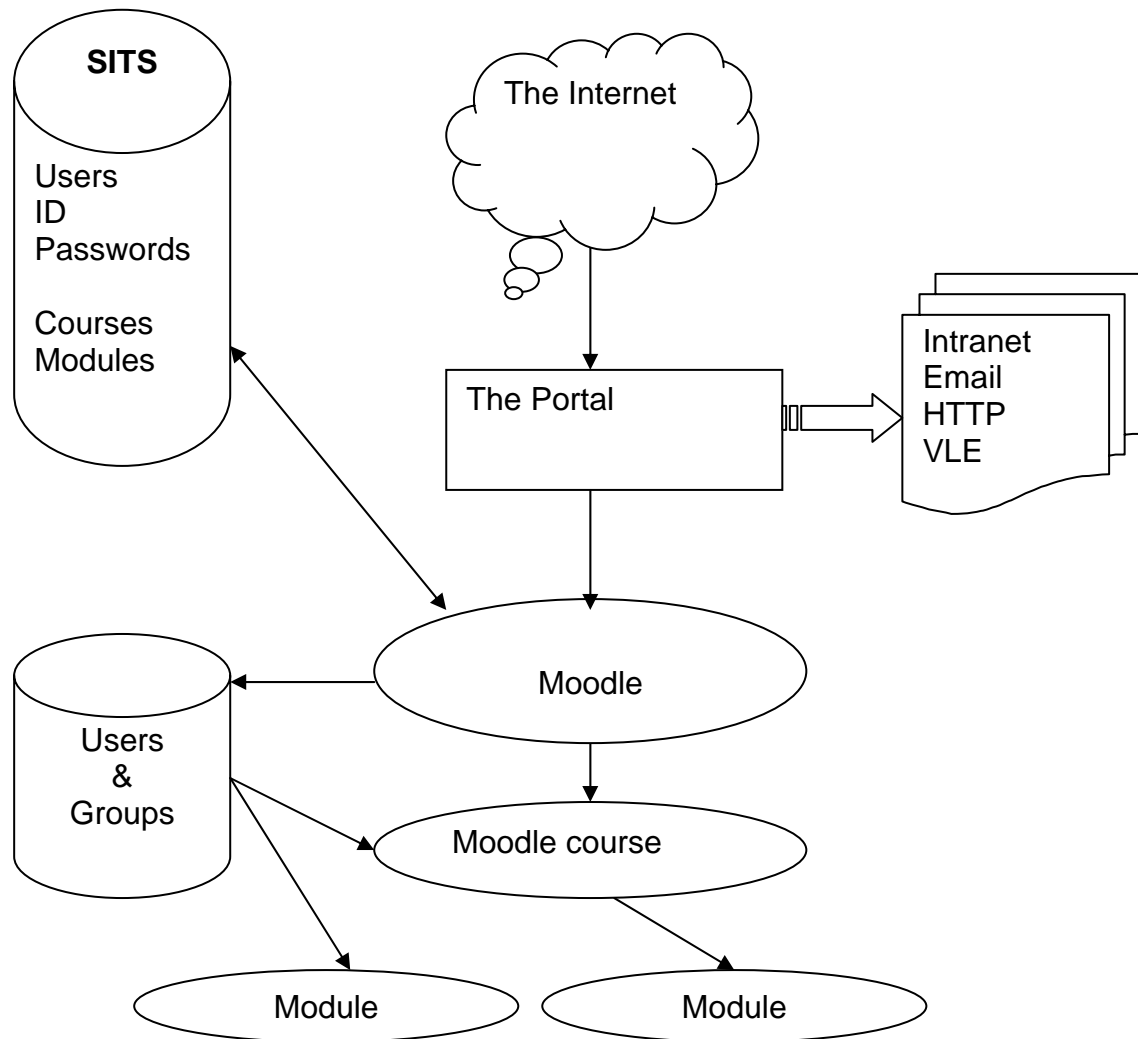


Figure 2 Proposed authentication method using SITS

The project managed to establish a streaming video server, based on a Windows 2003 MMS operating system. File sizes proved to be unexpectedly restrictive, previously streamed videos could be encoded at a bit rate of 500 Kbps, but these bit rates were unachievable with the VMware powered server. Videos had to be re-encoded at a lower rate of 340 Kbps to enable them to be streamed from the new virtual video server.

## Conclusion

The development of the pilot MLE was considered an overall success. The following conclusions can be drawn from the project findings:

- Moodle is a viable alternative to commercial software, not withstanding support costs.
- VMware allows multiple servers to be established, having the scalability capacity to quickly add new servers as required.
- VMware can provide video server functionality but streaming capabilities can be more restrictive despite broadband access.

- Moodle effectively integrates with the institutions existing lchain portal, avoiding multiple login points and potentially reducing administrative load.
- Existing course materials required restructuring to be logically presented in Moodle.

Although problems were encountered with the VMware, the E-Learning department remain committed to virtual servers as a more viable option than traditional methods. The E-Learning team also acknowledge the need to restructure existing files caused by Moodle's format could have greater implications when migrating all of the institution's courses over to the new VLE, potentially increasing development time-scales.

Direct VLE /SITS integration was not accomplished in time for the pilot course launch but single sign-on through the institution's existing portal via LDAP was achieved, providing a strong platform for final development and full migration of the college's courses for the start of the 2006-2007 academic year.

Feedback on Moodle's usability level compared to WebCT from lecturers attending training courses, has been positive from both novice VLE users and experienced WebCT authors. The topic and weekly structure of Moodle module design maps directly onto user knowledge of face-to-face teaching, shortening the learning curve of the new system and GUI.

Future MLE developments include the completed connection between VLE and Talis list systems, and a link to the institution's planned portal evolution, supported by an enterprise-wide content management system. The portal will provide students with personal information, linked to an object repository allowing the indexing, retrieving, and sharing of reusable learning objects. Moodle also allows students to register on courses themselves, an option that will be explored in the future as a means of reducing administrative load.

### References

- Alessi, A. M. & Trollip, S. R. (2001). *Multimedia for Learning: Methods and Development*. Needham Heights: Allyn and Bacon
- Allison, C., Bain, A., Ling, B., & Nicoll, R. Addressing Academic Needs in Managed Learning Environments. Retrieved March 15, 2004 from: <http://www.ics.ltsn.ac.uk/pub/conf2003/ColinAllison.pdf>
- Becta ICT Research. *A Review of the Research Literature on the Use of Managed Learning Environments and Virtual Learning Environments in Education, and a Consideration of the Implications for Schools in the United Kingdom*. Retrieved July 24, 2004 from: [http://www.becta.org.uk/page-documents/research/VLE\\_report.pdf](http://www.becta.org.uk/page-documents/research/VLE_report.pdf)
- Becta. (2003). *Virtual and Managed Learning Environments*. Retrieved March 15, 2004 from: [http://www.becta.org.uk/subsections/foi/documents/technology\\_and\\_education\\_research/v\\_&\\_mle.pdf](http://www.becta.org.uk/subsections/foi/documents/technology_and_education_research/v_&_mle.pdf)
- Boyle, T. *Towards a Theoretical Base for Educational Multimedia Design*. Retrieved January 30, 2004 from: <http://-jime.ac.uk/2002/boyle/boyle-paper.html>
- Brandl, K. (2005). Are You Ready To "Moodle"? Retrieved March 15, 2004 from: <http://lt.msu.edu/vol9num2/pdf/review1.pdf>
- Conole, G. (2002). Systematising learning and research information. Retrieved March 15, 2004 from: <http://www-jime.open.ac.uk/2002/7/conole-02-7.pdf>
- Cooke, K. (1999). Introduction to Apache. Retrieved April 8, 2004 from: <http://hotwired.lycos.com/webmonkey/99/22/index2a.html?tw=backend>

- Dougiamas, M. & Taylor, P., C. Interpretive analysis of an internet-based course constructed using a new courseware tool called Moodle. Retrieved March 15, 2004 from:  
<http://www.ecu.edu.au/conferences/herdsa/main/papers/nonref/pdf/MartinDougiamas.pdf>
- Druin, A. & Solomon, C. (1996). *Designing Multimedia Environments for Children*. New York: John Wiley & Sons Inc.
- Galmacci, G. & Milito, A., M. (2005). *Distance Learning: New Frontiers for Solving Old Problems*. Retrieved March 15, 2004 from:  
<http://www.stat.auckland.ac.nz/~iase/publications/14/galmacci.pdf>
- Holyfield, S. (2003). *Developing a Shared Understanding of the Managed Learning Environment (MLE) – the role of diagramming and requirements gathering*. Retrieved March 15, 2004 from:  
[http://www.jisc.ac.uk/uploaded\\_documents/ACF450.pdf](http://www.jisc.ac.uk/uploaded_documents/ACF450.pdf)
- Haug, H. (2002) *Toward Constructivism for adult learners in online learning environments*. Published: Vol 33, No2. *British Journal of Educational Technology*.
- Joint Information Systems Committee. *Overview of MLE issues and how JISC can help*. Retrieved April 16, 2006 from:  
[http://www.jisc.ac.uk/index.cfm?name=mle\\_overview](http://www.jisc.ac.uk/index.cfm?name=mle_overview)
- Laurillard, D. (1993). *Rethinking University Teaching*. London: Routledge
- Mishra, S. (2002) *A design Framework for online learning environments*. Published: Vol 33, No4. *British Journal of Educational Technology*.
- Neilsen, J. (1993) *Usability Engineering*. London: Academic Press Limited.
- Norman, D. (1988). *The Psychology of Everyday Things*. New York: Basic Books (Perseus)
- Nulden, U. & Hardless, C. *Activity Visualization and Formative Assessment in Virtual Learning Environments*. Retrieved July 25, 2004 from:  
<http://www.viktoria.se/nulden/Publ/avfa.pdf>
- Papert, S. (1980). *Mindstorms: Children, Computers, and Powerful Ideas*. Hemel Hempstead: Harvester Wheatsheaf.
- Ratschiller, T. (2000). *PHP from an IT Manager's Perspective*. Retrieved April 10, 2004 from:  
[http://www.linuxtoday.com/news\\_story.php3?ltsn=2000-06-06-002-04-NW-HL-SW](http://www.linuxtoday.com/news_story.php3?ltsn=2000-06-06-002-04-NW-HL-SW)
- Rand, J., Spiro, P. J., Feltovich, M., Jacobson, & Coulson, R. J. *Cognitive Flexibility, Constructivism, and Hypertext: Random Access Instruction for Advanced Knowledge Acquisition in Ill-Structured Domains*. Retrieved January 30, 2004 from: <http://www.ilt.columbia.edu/ilt/papers/Spiro.html>
- Rose, R. (2004). *Survey of System Virtualization Techniques*. Retrieved March 15, 2004 from: <http://www.robertwrose.com/vita/rose-virtualization.pdf>
- Salmon, G. (2002) *E-tivities: the key to online learning*, London: Kogan Page
- Schneider, D., K., Syneta, P., Fete, C., Giradin, F., & Morand, S. (2003). *Conception and implementation of rich pedagogical scenarios through collaborative portal sites: clear focus and fuzzy edges*. Retrieved April 2, 2004 from:  
<http://tecfa.unge.ch/proj/seed/catalog/docs/icool03-schneider.pdf>
- Stanford, S. & Chandrasekan, B. (2005). *Architectural Considerations for Creating High-Availability VMware VirtualCenter Infrastructures*. Retrieved March 15, 2004 from: <http://www.dell.com/downloads/global/power/ps4q05-20050285-Stanford.pdf>
- Strohecker, C. (1994). *The "Zircus" Concept Sketch for a Learning Environment and Online Community*. Retrieved January 10, 2004 from:  
<http://www.merl.com/reports/docs/TR94-22.pdf>

Technical Advisory Service for Images. (2006) Using Images in the Moodle Virtual Learning Environment (VLE). Retrieved March 15, 2004 from:  
[http://www.tasi.ac.uk/advice/using/pdf/vle\\_moodle.pdf](http://www.tasi.ac.uk/advice/using/pdf/vle_moodle.pdf)

Zhang, W. Linux Virtual Server for Scalable Network Services. Retrieved March 15, 2004 from: <http://www.linuxvirtualserver.org/ols/lvs.pdf>