Chapter 4
IT infrastructure: use of learning management system (LMS) and other applications

This chapter gives an overview of the adoption and usage of different software and techniques. It first focuses on the adoption, use and challenges of learning management systems (LMS), that is, software designed to provide a range of administrative and pedagogic services related to formal education settings (*e.g.* enrolment data, access to electronic course materials, faculty/student interaction, assessment). It reports the reasons for institutional decisions to use proprietary or open source systems, to prefer in-house developments or commercial outsourcing, and points to the challenges for further development, notably in terms of integration and functionalities. It also explores investment in IT infrastructure and usage of applications other than LMS by institutions in order to support or complement e-learning: IT networks; student portals; use of other teaching and learning related applications aside from an LMS; the extent to which administration (*e.g.* admissions, registration, fee payment, purchasing) has moved online; integration of academic and administrative systems; computer/network access for faculty and students; and strategy on online journals and e-books.

To what extent have ICTs penetrated the tertiary education sector? Is access to IT infrastructure and to appropriate software a barrier to e-learning development? This chapter gives an overview of the adoption and usage of different software and techniques. It first focuses on the adoption, use and challenges of learning management systems (LMS), that is, software designed to provide a range of administrative and pedagogic services related to formal education settings (*e.g.* enrolment data, access to electronic course materials, faculty/student interaction, assessment, etc.). It documents the increasing adoption of LMS and reports the reasons for institutional decisions to use proprietary or open source systems, to prefer in-house developments or commercial outsourcing, and points to the challenges for further development, notably in terms of integration and functionalities (4.1-4.2). While LMS adoption appears as one of the prominent features of e-learning development in tertiary education worldwide, the OECD/CERI and Observatory surveys reveal only limited impact in the classroom so far. The remainder of the chapter explores investment in IT infrastructure and

usage of other applications than LMS by institutions in order to support or complement e-learning: IT networks (4.3); student portals (4.4); use of other teaching and learning related applications aside from an LMS (4.5); the extent to which administration (*e.g.* admissions, registration, fee payment, purchasing) has moved online (4.6); integration of academic and administrative systems (4.7); computer/network access for faculty and students (4.8); and strategy on online journals and e-books (4.9). It will show that at many OECD/CERI case study institutions, development plans relating to IT infrastructure concentrated on extension of services (*e.g.* wireless) operation-wide, bandwidth management (to both offer sufficient capacity to accommodate greater use of audio and video, but also to manage student use) and overall quality of service.

4.1. Use of learning management systems (LMS) (Questions 2.2-2.6)

What is a learning management system (LMS)? In this book, the term LMS refers to software designed to provide a range of administrative and pedagogic services (related to formal education settings *e.g.* enrolment data, access to electronic course materials, faculty/student interaction, assessment, etc.). The most common such systems worldwide are Blackboard and webCT. Other terms used to describe such applications include "virtual learning environments" and "course management systems". Some use LMS to refer to a broader functionality that encompasses the above activities plus a range of other administrative tasks (*e.g.* relating to fee payment, human resources, fund raising, etc.); while others describe this broader configuration as a "managed learning environment" or with reference to use of adapted ERP (Enterprise Resource Planning) or CRM (Customer Relationship Management) systems. Use of LMS in this report refers to the narrow definition outlined above. Use of other applications, including ERP-type systems, is discussed in Sections 4.3-4.7.

Data from the OECD/CERI survey

Almost all sample institutions reported use of a "learning management system" (LMS). Table 4.1 presents the breakdown by type and number.

Only two sample institutions reported no current LMS use. One was predictable insofar as the institution had little experience with online learning. The other was a distance learning university with reportedly high levels of online presence across many of its programmes. This was a reminder that the LMS is not essential to online delivery. The institution concerned had, up to that point, made extensive use of email and online conferencing. However, it was notable that both institutions said that adoption of an LMS was under active consideration. So while not essential

to online delivery, these findings confirm the view that the LMS has become almost synonymous with e-learning in tertiary education. A few institutions, particularly those with less e-learning experience, made reference to a greater diversity of systems ostensibly under the LMS label, many of which performed specific functions rather than the broader construct of the typical LMS. These are included below.

Table 4.1. Type and number of LMS

Institution	Type	Institution-wide LMS	Local LMS	Type of LMS
Multimedia Kontor Hamburg	C	Clix Campus, WebCT	There are several others at faculty level	Proprietary; Clix Campus
Zurich University	C	OLAT, WebCT, BSCW	BSCW, Hyperwave, IBT Server	Open source, proprietary
Kyoto University	C	Under consideration	Under consideration	Undecided
University of Sao Paulo	C	CoL	Panda, FEA-EAD Online, CyberTutor	In-house
Carnegie Mellon University	C	Blackboard	CMU Online, OLI LMS	Proprietary; both local are in-house and at least OLI is open source
Aoyama Gakuin University	C	Dot campus	Financial Trading System	Proprietary
Asian Institute of Technology	C	VClass	Various (unidentified)	Open source (in-house); local use includes proprietary
University of California, Irvine	C	Electronic Education Environment, Moodle	None	In-house, open source
University of Paris Nanterre	C	E-Comete	None	In-house, open source
Monash University	C	WebCT	InterLearn	Proprietary, in-house
University of British Columbia	C	WebCT	None	Proprietary (but first developed in-house)
University of Maryland University College	M	WebTyco	None	In-house
FernUniversität Hagen	D	Platform 2003	None	In-house, open source
UK Open University	D	Under consideration	None	Undecided
UCLA Extension	D	Blackboard	None	Proprietary
Open Polytechnic New Zealand	D	Online Campus (moving to Moodle from mid-2005)	Blackboard (plan to discontinue from mid-2005)	In-house; proprietary. Open source from mid-2005
University of South Australia	M	UniSAnet	None	In-house
Virtual University of Tec de Monterrey	D	Blackboard, WebTec,	Docent, WebCT	Proprietary, open source (in-house)
Open University Catalunya	D	UOC CV	None	In-house (proprietary)

Note: C = Campus-Based; D = Distance; M = Mixed.

Source: OECD.

All other institutions have adopted at least one institution-wide LMS. Seven institutions (37%) reported use of a single, institution-wide LMS, and no local use of other systems. Three institutions cited two institution-wide systems (and again, no local use of other systems). The remainder combined simultaneous institution-wide and local activity.

Ten institutions (53%) reported use of proprietary systems, eight had installed such a system as at least part of an institution-wide arrangement, but only two of these positioned such as system as sole institution-wide application. The proprietary system used by one institution in fact began life as an in-house system at that very institution (webCT at University of British Columbia). Seven institutions made specific reference to current use of open source systems, and a further four implied that such a system was available. Four institutions made use of both proprietary and open source systems, but only two of these employed both types as joint institution-wide standards. No institution employed an open source system as sole institution-wide standard, and only one did so in combination with an in-house system. However, the Open Polytechnic New Zealand plans to drop Online Campus and Blackboard by mid-2005, and adopt Moodle (open source) from then on as sole institution-wide standard. Some institutions suggested that commitment to the incumbent LMS was stable, while others pointed to an ongoing search for an alternative.

A number expressed interest in emerging large-scale open source models (*e.g.* the new Sakai project in the United States (see Box 4.1). The Open Polytechnic New Zealand has been awarded government funding to lead a national consortium (now encompassing 20 institutions, including universities, polytechnics and private providers) to develop an open source "e-learning platform" (encompassing a portal and content management system, as well as core LMS). The project is also looking at how the consortium might organise hosting, helpdesk, technical support and staff development for member institutions (see Box 7.1 for an overview of New Zealand's e-learning strategy). It was envisaged that this system will eventually supersede the current LMSs at the institution. The University of Sao Paulo cited local government plans to fund a common LMS for all institutions in the area.

Eleven institutions mentioned in-house systems, six of which functioned as the sole institution-wide standard. An in-house system might be open source (in the sense that code is made available to third parties at no cost), or may be proprietary to the institution. One institution has made extensive adaptations to a third party open source system, effectively turning it into a "proprietary" system, but the terms of the original open source license may mean that the product remains open source. In-house systems were found across the institutional online development spectrum. Five of the most active

institutions reported in-house LMS development, but so did more mainstream and less developed institutions. The Open University Catalunya respondent noted that the institution's in-house (proprietary) LMS had been sold to other universities (*e.g.* Quilmes National University in Argentina) and to the private sector.

While the sample is small, these findings suggest that while leading proprietary vendors such as Blackboard and webCT have attained significant market share in tertiary education (and were the only proprietary systems to be mentioned by more than one institution), many universities have invested considerable resources in local systems. This offers a view of the LMS as valuable intellectual property for an institution, customised to local needs; as opposed to the mass market (if increasingly customisable) model of the leading commercial vendors, and the open source model of shared development. There was a pattern whereby distance learning/mixed mode institution generally reported in-house systems, while campus-based institutions more often made use of proprietary solutions. But there were a number of exceptions. It is interesting to speculate whether this scale of in-house development signifies valuable institutional autonomy over processes that are increasingly at the heart of instruction, or wasteful duplication of effort.

Data from the Observatory survey

The Observatory survey asked both whether respondents had implemented one or more LMSs (and whether implementation was institution-wide or local), and which systems were in use (see Table 4.2).

The figures are testament to the widespread and sustained perception of the value of institution-wide adoption of learning management platforms. Seventy-three per cent of respondents in 2004 (compared to 60% in 2002) claimed to have such a system in place institution-wide, with 90% expecting to make such a claim within five years. Asia-Pacific appears to be leading, with 84% of respondents citing a platform in place institution-wide, rising to a predicted 96% within a year. Australia and South Africa also reported extensive institution-wide adoption. Canada and the United Kingdom were about ten percentage points behind Asia-Pacific in terms of current implementation institution-wide, and exhibited greater numbers of respondents with longer development horizons. Predictions from low-middle income countries were equally optimistic (79% by 2009), although only one non-South Africa respondent cited current institution-wide implementation. Similarly, only one non-South African low-middle income respondent plans to implement in the next twelve months, with the remaining five citing a five-year horizon. Only 8% of all respondents (almost all in the United Kingdom and Canada) preferred department-led initiatives, and a negligible

3% dismissed learning management platforms as currently not being of strategic priority. It is notable that no Australian or Asia-Pacific respondent cited dependence upon local adoption.

Table 4.2. Has your institution implemented a learning management system (*e.g.* Blackboard/webCT) institution-wide?

	In place institution-wide	Institution-wide in 12 months	Institution-wide in five years	One + sub-sections of institution	Not a strategic priority	No response	Total
2004							
UK	35 (74%)	1	4 (9%)	6 (13%)	1	0	47
Canada	22 (73%)	2 (7%)	3 (10%)	3 (10%)	0	0	30
Australia	15 (79%)	3 (16%)	1	0	0	0	19
South Africa	8 (80%)	0	0	1	1	0	10
Asia-Pacific	21 (84%)	3 (12%)	1	0	0	0	6 (25)
LMI	9 (47%)	1	5 (26%)	1	3 (16%)	1	10 (20)
Returning	34 (85%)	2 (5%)	2 (5%)	2 (5%)	0	0	(40)
TOTAL	**87 (72%)**	**7 (6%)**	**13 (11%)**	**10 (8%)**	**4 (3%)**	**1**	**122 (100%)**
2002							
Developing	9 (41%)	5 (23%)	3 (14%)	1	3 (14%)	1	22
Other developed	28 (76%)	6 (16%)	1	1	0	1	37
UK	24 (57%)	8 (19%)	5 (12%)	4 (10%)	1	0	42
Returning	26 (67%)	6 (15%)	5 (13%)	1	1	1	(40)
TOTAL	**61 (60%)**	**19 (19%)**	**9 (9%)**	**6 (6%)**	**4 (4%)**	**2 (2%)**	**101 (100%)**

Source: OBHE.

Analysis of 2002 and 2004 data for returning respondents reinforces the above trends. Out of 11 (28%) returning respondents that in 2002 indicated

plans to implement a learning platform institution-wide (whether within twelve months or up to five years), eight reported success by 2004. Two respondents reported to still be in the development stage, and the remaining institution cited implementation at a departmental level. However, as will be clear from earlier discussion, institution-wide implementation of a learning platform does not necessarily equate to institution-wide use of online learning, whether on-campus in some form or at a distance. There is a striking contrast between rate of institution-wide adoption of learning platforms, and the extent to which substantive online presence has penetrated mainstream courses/programmes. When asked to indicate the proportion of current courses/programmes with various levels of online presence (see Chapter 1), responses were hardly indicative of revolutionary change. In 2004, on average respondents reported that 44% of their existing courses/programmes had no or trivial online presence, while an average of 32% of provision had "modest" online presence (*e.g.* course information and lecture notes online). Although an average of 15% of classes had "significant" online presence (incorporation of key "active" elements online such as online discussions and assessment tools), only 6% of campus-based provision was said to have an online presence sufficient to significantly reduce face-to-face classroom time. On average, a mere 4% of provision was "wholly or very largely conducted online". The same disparity is reported in the United States. In 2003, while 82% of institutions have adopted a "single product standard for a course management system", an average of only 34% of "classes" make use of such a system (Green, 2003, p. 15). One study of LMS usage concluded that such systems are "highly valued by many but used innovatively by only a few" (Dutton *et al.*, 2004, p. 147).

It will be interesting to see whether, and the rate at which, platform adoption spurs classroom adoption, and whether the bulk of provision will settle at the "modest" level, or continue to progress into "significant" presence and beyond. Overall, as discussed in Chapter 1, comparison with 2002 data suggests some progress, with the "non/trivial" category falling from 49% to 44%, "modest" stable, "significant" (not split in 2002 between significant reduction and non-reduction of classroom time) up from 15% to 25% and "wholly online" stable.

Another indication of the relative immaturity of online learning in many institutions concerns the low level of adoption of "content management systems" (*i.e.* software where electronic content is split into "learning objects" able to be manipulated and recombined for multiple purposes – see Chapter 3). "Content management" pushes online learning beyond administrative enhancement into the core of materials development and delivery. Overall, the rate of institution-wide adoption climbed slightly from

4% in 2002 to 6.6% in 2004, with the bulk of institutions (61% – down from 64% in 2002) citing implementation as a strategic priority on a one- to five-year horizon. Between 2002 and 2004 a number of learning platform vendors have developed content management functionality in some form, but widespread institutional adoption by this means is not apparent in the 2004 data. Indeed, one explanation in line with the above analysis is that institution-wide implementation and faculty adoption of learning platforms are in many institutions presently concerned with core administrative functionality only, rather than direct application to materials development/teaching. This is supported by evidence from the United States, which found student use/competence of LMS (and ICT generally) to typically be similarly limited (Kvavik, Caruso and Morgan, 2004).

All Observatory respondents were asked whether their institutions offered faculty members any formal incentives to develop online teaching and learning. Thirty-four per cent said "yes", 50% "no", and 16% maintained that an incentive programme was under development. The absence of specific incentives may be another factor in the disparity between online infrastructure and faculty adoption.

Platforms employed

Table 4.3 summarises which platforms Observatory respondents employed.

WebCT emerged as the most popular platform. Almost 46% of respondents had instituted webCT institution-wide (37% in 2002), compared to 22% in the case of Blackboard (19% in 2002) and 12% for in-house systems (5% in 2002). The webCT figures were skewed by the much higher Canadian return in 2004 (see below). If Canadian institutions are excluded, webCT's share of the total is reduced to 38%, in line with 2002 figures. In the United States, Blackboard outdid webCT in 2003, with over 40% of respondents citing Blackboard as their "single product standard", compared to almost 33% for webCT. "Other" systems (including Lotus Learning Space and eCollege) made up about 9% of US returns (Kvavik, Caruso and Morgan, 2004). In the 2004 Observatory survey, the growth in use of in-house systems is notable (and supports the case study findings above), but it should be borne in mind that in-house systems were least likely (compared to Blackboard, webCT, open source and other) to be the sole institution-wide system. Also, returning respondents presented no growth in this area, suggesting sampling as a factor behind the general increase. Only four institutions reported institution-wide implementation of an open source system, plus one installation of Lotus Learning Space and six instances of "other" systems. Only three institutions (2.5%) had installed solely an open

source system, nine (7%) solely an in-house system and six (5%) solely an "other" system.

Table 4.3. Observatory respondents by LMS

	Black-board	Lotus Learning Space	webCT	Open-source system[1]	In-house system	Other	Under consideration	None	Blank	Total
2004										
UK	17 (15)[2]	0	16 (14)	1 (1)	5 (4)	2 (2)	4	1	0	47
Canada	0	1 (0)	21 (18)	2 (1)	6 (2)	2 (2)	0	0	0	30
Australia	6 (5)	0	12 (11)	0	0	1	0	1	0	19
South Africa	0	0	5 (4)	1 (1)	0	0	1	2	0	10
Asia-Pacific	8 (8)	0	14 (12)	0	4 (3)	0	0	1	0	25
LI/LMI	2 (2)	0	4 (4)	1 (1)	0	2 (2)	3	7	1	20
Returning	14 (11)	0	20 (15)	2 (2)	2 (0)	2 (2)	2	2	0	40
TOTAL	**27 (25)**	**1 (0)**	**56 (48)**	**4 (3)**	**15 (9)**	**6 (6)**	**7**	**9**	**1**	**122**
2002										
Developing	2 (1)	0	7 (6)	N/A[1]	1 (0)	1 (0)	5	12	0	22
Other developed	10 (8)	0	20 (19)	N/A	2 (1)	4 (2)	1	0	1	37
UK	10 (10)	0	12 (12)	N/A	2 (2)	2 (2)	4	1	1	42
Returning	12 (10)	0	17 (17)	N/A	1 (0)	3 (2)	4		5	40
TOTAL	**22 (19)**	**0**	**39 (37)**	**N/A**	**5 (3)**	**7 (4)**	**10**	**13**	**2**	**101**

1. This category was not included in the 2002 survey.

2. The figures in brackets represent the number of institutions which have implemented a particular platform as a single standard institution-wide. The other figures represent those institutions, plus those that reported implementation of more than one platform institution-wide. The columns do not add up to the total number of respondents in each category due to the fact that institutions were able to tick more than one option.

Source: OBHE.

The combination of systems varied between respondents. Only three institutions (2.5%) had implemented both webCT and Blackboard

institution-wide. The other institutions reporting implementation of more than one system combined either Blackboard/webCT and an in-house/other system, or combined Lotus Learning Space and "other", or open source and "other". The most commonly cited open source systems were Moodle, Claroline and LON-CAPA. "Other" systems cited included First Class, Learnwise and Centra.

There were notable differences between countries. In Canada, out of the 28 institutions reported to have deployed an LMS institution-wide, 22 (79%) used webCT, and 18 used webCT as their only institution-wide system. No Canadian institution reported the use of Blackboard. The dominance of webCT in Canadian institutions may be due to the Canadian origins of the system (University of British Columbia). Blackboard was also absent from South African returns. In Australia, webCT outdid Blackboard by about two-to-one, while in the United Kingdom; institutions were more or less equally divided between the two leading vendors.

Out of the 105 institutions that reported at least one institution-wide LMS, thirty (29%) also reported faculty/department use of other systems. This in fact represents a small rise compared to 2002, where only 25% of institutions that reported at least one institution-wide LMS also reported local use of other systems. This rise may represent better central knowledge of local activity, alongside possible higher incidence of local activity. It was not possible to gauge the extent to which local LMS use constitutes dissatisfaction with central arrangements (*e.g.* preference for a discipline-specific tool).

In respect of returning respondents, 23 out of 29 (79%) institutions that cited institution-wide use of an LMS in 2002, referred to the same system in 2004. Of the remainder, one moved from webCT to Blackboard, one switched from "other" to Blackboard and webCT, and two shed in-house/"other" systems in favour of a single institution-wide implementation (either Blackboard or webCT). These findings suggest further consolidation in favour of the two leading vendors. Two institutions appeared to have given up institution-wide implementation altogether. These two institutions were South African, perhaps reflecting infrastructure changes associated with the institutional merger programme underway across the country. Of the remaining eleven returning respondents (*i.e.* those that did not cite institution-wide LMS adoption in 2002), six had achieved this by 2004.

Overall, the data reinforce the LMS adoption trend seen in 2002, and the dominance of the two leading vendors, Blackboard and webCT. Institution-wide LMS implementation is now the overwhelming mode of adoption in Commonwealth universities. As noted above, the LMS is an e-learning success story, and has become all but synonymous with e-learning in tertiary

education. However, LMS adoption is primarily a matter of fund allocation and technical implementation. The ways in which and the extent to which individual faculty adopt such tools (compare average rates of "online presence" at course/programme level with rates of LMS adoption) is a more complex equation.

4.2. LMS challenges (Questions 2.3-2.6)

The fact that LMS adoption strongly increased without necessarily leading to more e-learning raises the question of their actual use and current limitation according to institutions. The OECD/CERI survey requested the case study institutions to report on LMS functionality, usage trends, integration with other systems and locus of control.

Functionality

In those cases where the institution listed LMS functionality, there was little to choose between different systems (aside from different versions of the same system). The past seven years of intensive LMS development and adoption in tertiary education have seen considerable system convergence, along with steady updating and additional features (*e.g.* content management). Some respondents asserted that a particular system was the "only genuine" enterprise LMS, or "by far the easiest" to use, but it was difficult to evidence such claims. Others voiced the complaint that the leading commercial systems were insufficiently responsive to diverse pedagogies, while some disagreed (again, different versions of the same system accounted for some of these differences). One institution speculated that concern about lack of flexibility may sometimes reflect "self-protection" by academics who feel uncomfortable with the "sudden" significance of the LMS.

Those institutions with in-house programmes often pointed to the lack of a commercial alternative as the initial motivator for local development. For example, the University of South Australia system, UniSAnet, was envisaged as a non-technical interface accessible from the desktop and not requiring special plug-ins or programmer interventions. Many embarked on such work prior to the post-1997 LMS boom[1] (and prior to aforementioned systems convergence and mainstreaming), although others have more recently resorted to in-house development despite the plethora of commercial/open options. One institution cited sensitivity to variable regional bandwidth as a key consideration for development of an in-house LMS. Institutions with two or more enterprise-wide systems often cited

1. For a study of two of the leading providers, Blackboard and webCT, see Garrett (2002).

choice as a useful way to address faculty concerns about being tied to a single solution. For commercial systems, some institutions adopted an LMS after market analysis (one respondent surveyed 171 vendors against 180 variables, and eventually trialled five systems, before selecting two), some adopted the system used by a partner institution (whether academic or commercial) and one (University of British Columbia, as noted above) cited a historical connection. The edutools website, hosted by WCET (a co-operative in the United States dedicated to the enhancement of effective use of technology in higher education) is a resource that allows the user to compare a wide range of LMS across many functions and features. Edutools have now also developed an equivalent resource for content management systems (see *www.edutools.info/*).

The debate about the merits of particular commercial systems, commercial versus in-house versus open source is ongoing, despite what is arguably manifest convergence between different systems in terms of core functionality. Large-scale open source efforts, such as Sakai in the United States, Learning Activity Management System – LAMS (developed at Macquarie University, Australia, and with international support) (see Box 4.1) and the New Zealand Open Source Virtual Learning Environment (NZOSVLE) project (see Box 7.1), are predicated on a desire for non-proprietary models (on cost and code access grounds), but as importantly on a conviction that leading commercial systems are overly content-centric.

One of the future challenges with LMS functionality and usage will be the development of technologies supporting collaborative learning environments. To quote the LAMS website: "E-learning has a well developed approach to the creation and sequencing of content-based, single learner, self-paced learning objects. However, there is little understanding of how to effectively create and deliver sequences of learning activities which involve groups of learners interacting within a structured set of collaborative environments, or how teachers can make these sequences easily re-usable".[2] The rationale behind the (incomplete) in-house LMS developed with Sun Microsystems for the defunct UK eUniversity was similar (Garrett, 2004). The question is whether such systems can develop demonstrably different and superior functionality to commercial incumbents, and whether the latter will continue to outflank the former in terms of innovation. The underlying question is the extent to which the functionality of the LMS itself dictates pedagogy versus the influence of the practitioner and their informed use of particular "standard" LMS tools (Carmean and Haefner, 2002).

2. Website of the "Learning Activity Management System". Available at: *www.lamsinternational.com/about/*

Box 4.1. Sakai/LAMS

Sakai and LAMS are two open source initiatives designed to enhance the functionality of core education software (*e.g.* learning management systems, portals, assessment tools, etc.). Both subscribe to a vision of e-learning as rooted in interoperability and as pedagogically flexible, and support community rather than proprietary development (and encourage the interoperability of proprietary software with third party applications). Both subscribe to the view that leading proprietary systems (notably popular learning management systems such as those from Blackboard and WebCT) have critical ownership and pedagogic limitations.

The Sakai Project is a US$6.8M community software (*i.e.* open source but involving more specific commitments from participants) development project founded by the University of Michigan, Indiana University, MIT, Stanford, the uPortal Consortium, and the Open Knowledge Initiative (OKI) with the support of the Andrew W. Mellon Foundation. Sakai builds on a number of pre-existing applications in particular member institutions, with a view to the creation of "code mobility", improving interoperability between institutions and synchronisation of need. The aim is to enhance functionality, simplify implementation/development and reduce costs. Products will include an Enterprise Services-based Portal, a complete Course Management System with sophisticated assessment tools, a Research Support Collaboration System, a Workflow Engine, and a Technology Portability Profile as a clear standard for writing future tools that can extend this core set of educational applications. The first release was in July 2004. The Sakai Educational Partners' Programme (SEPP) extends this community source project to other academic institutions around the world, and is supported by the William and Flora Hewlett Foundation and SEPP member contributions.

LAMS is more focused on teaching and learning software, specifically the development of a "revolutionary new tool for designing, managing and delivering online collaborative learning activities". The initiative is based at Macquarie University in Sydney, Australia, and is the combined effort of the LAMS Foundation (a non-profit company), LAMS International (a commercial services firm) and the Macquarie University E-learning Centre of Excellence (MELCOE), a dedicated research centre focused on e-learning technology and standards development within Macquarie University. The rationale behind LAMS is that much e-learning to date has been structured in terms of learner interaction with content, rather than interaction with teachers/peers. The developers behind LAMS argue that social interaction is a key component of learning. Arguing that the current concept of learning objects is too content-centric, the developers are using an emerging educational meta-language (drawing on instructional management systems [IMS] and other components) to describe learning processes independent of subject, content and technology. From February 2005, it is planned to make LAMS open source and freely available. LAMS International, the commercial services part of the initiative, offers a range of installation and support services for institutions not wishing to go it alone. LAMS will be available under a dual license arrangement allowing third parties to buy the software and integrate with proprietary applications (and thus not be forced, as under a conventional open source license, to make the integrated software available as open source to others).

The project website can be found at: *www.sakaiproject.org/* and *www.lamsinternational.com*

Source: Sakai and LAMS.

Integration with other systems and open standards

There is evidence of a strong trend towards standardisation on a single system, and integration with a range of administrative programmes (*e.g.* student records, admissions, assessment, finance, etc.). There are examples of government funding for such work (*e.g.* The Joint Information Systems Committee's (JISC) "Linking Digital Libraries with Virtual Learning Environments" programme) and attempts to build-in integration from the outset (*e.g.* the Sakai project aims to facilitate linkages between the core LME and library systems, object repositories, etc.). By definition, 100% virtual institutions reported more advanced development in this respect, while campus-based institutions or other distance institutions are in the midst of typically complex integration strategies. Some institutions have created LMS-compatible administrative systems to facilitate integration, often turning to the LMS vendor for assistance. However, some institutions have not addressed integration as yet, largely because of its second-order characteristics (*e.g.* some institutions have yet to embark on significant LMS use). One respondent was unusual in commenting that such integration was considered unnecessary because students "expect" to have to go to different places for different things. Many institutions regarded LMS integration with other systems as part of a broader "portal" strategy (see below). One institution highlighted the "problem" whereby greater systems integration revealed shortcomings in data quality/consistency, suggesting that integration is more than a technical issue.

A number of institutions appreciated the shift to so-called open standards (*i.e.* common technical standards that afford interoperability between applications from different sources) by leading vendors such as Blackboard and webCT, offering enhanced customisation and integration with third party applications. It might be argued that this compromise between proprietary and open source was embraced by vendors partly to head-off the "threat" from open source. Vendors face a tension between maximising interoperability with third parties (with the risk that the core product all but "disappears", resulting in what might be described as an expensive "open source" system), and focusing on making the core product as high quality and flexible as possible, reducing the need for interoperability in areas that might be considered (or become) core functionality. The latter strategy asserts the proprietary LMS an all-encompassing solution, with all the R&D and high prices this implies. Raising the quality of the "out-of-the-box" solution might also be regarded as a good defence against open source. Moreover, proprietary vendors are selling a range of support services, trying to persuade institutions that neither LMS development nor support are core business for higher education institutions. The danger for vendors is that open standards may generally be

adopted to the point where the "programming commitment" for a university in adopting an open source LMS is significantly reduced. The Open Polytechnic New Zealand respondent argued that the New Zealand government's support for a national open source e-learning strategy was in many ways aligned to this outcome (see Box 7.1).

Locus of control

In terms of locus of control over LMS content development, most institutions reported a highly devolved system, whereby academic staff had considerable control over whether, when and how to post content, and over the nature of that content. As one would expect, such an approach favoured academic autonomy, but also meant inconsistent presentation/quality. All institutions reported some form of central unit or units that offered advice and support to academic staff in this area, and typically responsible for underpinning technical support. Another model was much greater central control vested in such a unit, requiring all academic staff to discuss their plans and to an extent conform to centralised instructional design. In a mirror image to the devolved model, the centralised approach ensures consistency of presentation/quality, but was said to also lead to a somewhat bland homogeneity.

Another problem is bottlenecks whereby central action is needed for even minor changes to the content. The Open Polytechnic New Zealand was in the process of reducing centralisation in an attempt to combine the best elements of the two models. Adoption of Moodle (enabling greater local control of online course development and maintenance, disrupting conventional roles and responsibilities), plus dedicated staff development, was said to have advanced this agenda. A centralised approach was typically found in either recently created virtual institutions, or those with a weaker tradition of academic autonomy.

Staff and student usage

In terms of LMS usage, no institutions had precise figures, although some offered considerable detail. By definition, dedicated virtual institutions reported almost universal usage by staff and students. One mixed mode institution cited majority usage (but did not collect specific data), and among the more active institutions (as defined by Question 1.6) that provided data, staff usage range from about 20-40%. One less active institution estimated that "only a few percentage of academic staff" were using the in-house system.

Kyoto University cited little LMS use, arguing that most systems were not particularly suitable for their domestic students, on grounds of medium

(personal computer – domestic students said to have a preference for mobile phones) and pedagogy (assuming student/teacher/peer interaction as central to the learning process – whereas domestic students were said to embody a more "passive" approach to learning). Japanese students were said to be generally not willing to "study by themselves". This highlights the issue of the LMS as an increasingly global product (particularly Blackboard and webCT), and the tension between mass marketing and local customisation. The comments may also reflect a perception of "e-learning" as distance learning, rather than a supplement to face-to-face contact. The comment that an LMS is characterised by student/teacher/peer interaction can be juxtaposed against the more general criticism of the LMS as overly content-driven.

4.3. IT networks

The OECD/CERI survey also asked to report about other IT applications than LMS. All sample institutions reported significant and ongoing investment in IT networks to support on-campus activity and/or distance learning, and many reported adequate functionality/bandwidth to support e-learning in the short-to-medium term. On campus, the standard model was Ethernet linked by fibre optic connections between buildings/campuses (typically one gigabit backbone, and around 100 megabit to the desktop) – with some institutions reporting plans to upgrade to one gigabit Ethernet within buildings. To give an indication of capacity, a number of institutions reported operation-wide multicast streaming functionality, or cited imminent upgrades to this effect. Some institutions reported examples of ongoing dependence on BNC cables as well as Ethernet.[3] Many institutions were connected to both the commodity Internet and dedicated, higher bandwidth academic networks (*e.g.* Internet 2). The sample included some of the pioneers on IT networks in tertiary education. For example, in the early 1980s the Carnegie Mellon University developed one of the first distributed networks of computer workstations in the United States. From the mid-1990s, all offices, classrooms and student dormitories at the institution have had Ethernet connections.

The current capacity of IT networks at most sample institutions were seen by some respondents to foreshadow greater use of audio and video in e-learning (above and beyond traditional usage such as audio/video lectures). The Carnegie Mellon University respondent was enthusiastic about peer-to-peer video conferencing, and institutional repositories of short

3. BNC Cables are used to connect two or move computers to share files and printers, etc. Ethernet refers to a local area network allowing several computers to transfer data over a communications cable.

videoed explanations of key topics. Some respondents expressed concern about cost of bandwidth, and whether this might prove an obstacle to scaling up e-learning. The Open Polytechnic New Zealand is a member of the "Next Generation Internet New Zealand" consortium, working on faster connectivity. The UCLA Extension respondent cited the position of the parent institution as a barrier, insofar as the institution did not view distance learning as a key strategy. This meant that UCLA Extension did not sufficiently benefit from the parent institutions experience/applications, and larger resource base.

The Observatory survey asked respondents to indicate the importance of "upgrading campus technology infrastructure" over the next three years (5 signalled "very high importance" and 1 "very low importance"). The overall average score was 4.1, indicating high importance. Canadian institutions reported, on average, the lowest importance (3.9), while low income/low-middle income produced the highest average score at 4.3. Only three institutions (one in Canada, one in a low income/low-middle income country and one in the United Kingdom) entered a score of one or two – indicating low or very-low importance. Thirty-four per cent of respondents entered "5" for this question, suggesting that in many institutions current infrastructure is perceived to be critically inadequate despite the fact that most case study countries have already worked on major programmes/projects to support infrastructure, and the trend is now shifting towards contents developments and process support (see Annex 4).

In terms of wireless access, most case study institutions (where relevant) reported at least partial campus coverage – *e.g.* major meeting and conference facilities and a growing number of classrooms; or one out of a number of campuses; and some (*e.g.* University of British Columbia) institution-wide coverage. Again, Carnegie Mellon University is a leader in the field. From 2000, the entire campus – including student dormitories – has been covered by an 802.11b wireless network, which currently has over 9 000 individual registrations. This respondent reported dramatically increased usage of the wireless network since complete coverage was achieved. Indeed, the wireless network has become the primary network, and was said to be enabling forms of e-learning. For example, faculty was said to increasingly depend on the wireless network for in-class presentations and assignment of in-class computer-based work. To accommodate growing usage and higher bandwidth, Carnegie Mellon University planned to upgrade to 802.11g/a. Those institutions with limited or without wireless access (*e.g.* Aoyama Gakuin University), reported development plans, and expected future demand from students. The University of Paris Nanterre stated that blanket wireless coverage was key to mainstreaming e-learning. Other respondents (*e.g.* Monash University) cited

obstacles to further wireless development, such as competing standards and low student laptop ownership.

In general, there was nothing to suggest that wireless would replace "wired" infrastructure in the short-to-medium term. Higher cost and functionality limitations of wireless modalities point to wired and wireless as complementary, serving different purposes and meeting different needs (Paulsen, 2003). This dual future may mean higher infrastructure costs for institutions.

Among Observatory respondents, only 8% reported an institution-wide wireless network, but a further 61% reported partial coverage. Sixteen per cent cited implementation plans (either partial or total) and 15% indicated that wireless functionality was currently not a strategic priority. Total/partial coverage was highest in Asia-Pacific (88%), then in Canada (80%), then in the United Kingdom (72%), then in low income/low-middle income countries (21%).

4.4. Portals (Question 2.7)

A portal refers to a single gateway to a range of academic and administrative information/services, typically with single sign-on. Many institutions in the OECD/CERI sample had functional portals, and were gradually extending their coverage and functionality (often under the auspices of a dedicated committee). Common functionality included searching the course catalogue, course registration, access to assessment results, library access and course syllabi; with different levels of access (and personalisation options) for students, staff and faculty. Some institutions mentioned plans to integrate the portal with other systems (*e.g.* finance and LMS). Other portals were more limited, *e.g.* just general information about e-learning systems and programmes. At some distance learning institutions, particularly dedicated online universities such as the Open University Catalunya, portal functionality has been integral to institutional development from the outset. Some portals were developing in-house out of student information systems (*e.g.* SIS at Asian Institute of Technology, or what was described as a "minimal links engine" at the University South Australia), while others were purchased from vendors (*e.g.* the Vignette Portal adopted by Carnegie Mellon University), or were the fruit of collective open source development (*e.g.* Uportal in the United States; and adaptation of Tiki Wiki groupware and content management software at the Open Polytechnic New Zealand). University of Maryland University College reported plans to roll out dedicated portal functionality as part of third party ERP (Enterprise Resource Planning) installation.

Many installations were recent, inhibiting any in-depth evaluation of value and usage. At the Open Polytechnic New Zealand, a new and expanded portal was a key component of a planned new platform framework, encompassing a range of open source tools being developed with government funding and in partnership with a number of other local tertiary education institutions and other organisations (see Box 7.1). At the UK Open University, the planned LMS was seen to subsume the current portal functionality, rather than vice versa as on the traditional conception. Clearly, it is misleading to draw sharp lines between what is an LMS, what is a student information system and what is a portal. The overarching vision is application integration. Indeed, a functional student information system is critical to portal development. The Zurich University respondent said that improvement of its central information system was underway with a view to university-wide portal adoption in 2005.

A number of respondents articulated a rationale for portal development. The Carnegie Mellon University respondent argued that "without the capacity to aggregate and personalise information available on the university intranet (along with a powerful search), individuals will have a harder and harder time finding the information and resources they need to operate." The Monash University respondent agreed, saying that portal development was in response to growing user frustration at finding information, and multiple entry points offering sometimes conflicting or different information. A key challenge was to make the portal the single entry point for all users, including those outside the university. Only then would the portal fulfil its role, and enable single sign-on. While the technology was viewed as immature and understanding of its potential was poor, the Carnegie Mellon University respondent expected the portal to become the primary means for students, faculty and staff for inputting and obtaining information.

In response to the Observatory survey, 31% of institutions reported an institution-wide portal system currently in place, and a further 24% said that such a system would be in place within a year. Another 24% indicated that implementation would take place within five years. A handful cited local portal usage, and 17% said that an institution-wide portal was currently not a strategic priority. In terms of current institution-wide implementation, about 50% of Asia-Pacific respondents (dominated by Australia) made a positive response, compared to about a third in Canada and the United Kingdom, and about 15% in low income/low-middle income countries. In the United States (with lower figures reflecting sample size), the figures for 2003 were 28% for portal in operation, plus a further 19% for installation within a year. Interestingly, in contrast to LMS take-up, the US figures suggested much higher use of in-house portals. Only Campus Pipeline (now owned by SunGard – a US$3 billion software and information management firm

specialising in financial services) was more frequently cited than than "homegrown/local" category (Green, 2003, p. 14). As the portal grows in significance in tertiary education, commercial interest and consolidation will grow, not least from leading LMS vendors wary of diminution as a result of platform integration.

4.5. Use of other teaching and learning-related applications (Question 2.8)

Sample institutions were asked to comment on any other tools or platforms that are widely used at their institution in support of e-learning. The examples given in the question (instant messaging and handheld computers) generally directed responses to applications of that sort, rather than standalone disciplinary software (mentioned by almost no respondents, despite what one may assume is widespread use in many subjects). Those institutions with less experience of e-learning typically reported no significant use of other tools or platforms – although steady rollout of wireless coverage was reported by some to prefigure wider use of handheld computers and other collaboration tools.

A common situation was that reported by the Open Polytechnic New Zealand. This respondent stated that while some faculty use instant messaging and other standalone tools (*e.g.* Macromedia resources and video-conferencing), activity was said to be small-scale, not centrally supported and rarely integrated into formal e-learning. The major sites of activity were institutions with longstanding experience of forms of e-learning, pre-dating the LMS boom. As the LMS grows in dominance and scope in tertiary education, the trend is for the LMS to absorb/supplant previously standalone technologies. As in response to the portal question, Open University Catalunya stated that the institution's LMS "Virtual Campus" had been built/modified over time to encompass all required functionality. The trend for leading LMS vendors (*e.g.* Blackboard and webCT) to enable interoperability with third party applications (such as instant messaging, video conferencing, etc.) means that the line between LMS and non-LMS applications has begun to blur. For example, the Virtual University of Tec de Monterrey cited a wide range of tools (library, collaboration, assessment, video) but it was not clear whether these were standalone or part of an LMS.

Among the major sites of activity were Carnegie Mellon University and the University of British Columbia. At Carnegie Mellon University, both a discrete instant messaging system and bulletin board service are in widespread use and pre-date the contemporary LMS-centric model of e-learning. These have long been used at this University as tools for peer

and student/faculty communication outside the classroom. Both were reported to be gradually giving way to "free" commercial instant messaging services from the likes of AOL and Microsoft, and to LMS-based tools, such as Blackboard's bulletin board function. The Carnegie Mellon University respondent complained of points of inadequate functionality in the latter – particularly lack of integration between bulletin board postings and email notification. Another longstanding tool at this University is the "Andrew File System" (AFS). This allows a student to submit computer programming assignments to a particular location, where the assignment is then graded automatically. While commercial automated assessment tools are now commonplace, no supplantation of AFS was reported. This institution cited AFS as a harbinger of the future of e-learning, seen to involve increasing use of intelligent automated feedback programmes. This was seen to have application beyond formal systems such as computer science. The Head of the English Department at Carnegie Mellon University, Prof. David Kaufer, was reported to have developed an automated tool to parse text for reader response patterns, and uses it as part of feedback to composition students. Finally, as part of its wireless initiative, the institution has invested in handheld computers (*e.g.* as student response tools in class, and collaboration tools outside), but the respondent reported minimal usage to date, and questioned the cost/benefit analysis (*e.g.* the view that handheld functionality was too limited relative to cost).

At the University of British Columbia, initiatives included a pilot of electronic portfolios, allowing students (and faculty) to build an online portfolio of their academic and other achievements, supporting both educational and employment purposes. The university is trialling a number of solutions including a vendor hosted tool called iwebfolio from a firm called Nuventive, a tool under the webCT umbrella and the open source OSPI system.[4] The overall aim, in line with the University of British Columbia's portal investment, is to "strengthen students' and staff's ability to manage, store, be assessed upon their work products, demonstrate their individual competencies and be more reflective learners and practitioners". A number of science classes were reported to be using simple student response technology in the classroom, and faculties/schools of medicine, nursing and education were said to be engaged in Personal Data Assistant (PDA) trials (*e.g.* issuing PDAs to medical/nursing students in their experience year, to given them handheld access to a wide range of text resources, and to keep them in touch with the university). Use of blogs (personal online commentaries/journals) and wikis (simple website

4. The Open Source Portfolio Initiative.

creation/editing tools) were also said to be increasingly used at the University of British Columbia, with examples of pedagogic application.

Late adopters of an LMS, or cases where an LMS had not yet been adopted, also reported high usage of other tools and platforms. For example, the UK Open University cited a number of standalone systems – computer-mediated conferencing, audio conferencing, interactive whiteboard, assignment handling and digital library. Additional examples of use of others tools and platforms included use of mobile phones to access student information (Kyoto University – utilising a tool widely owned by students), and uses of SMS messaging as a basic communication tool (one faculty at Zurich University). The UCLA Extension respondent mentioned website creation software such as Adobe's GoLive and video editing software such as Apple's Final Cut. The University of South Australia, as part of a state-wide initiative, is using US firm Centra's synchronous video/audioconferencing system.

4.6. Online applications for administration

Alongside aspects of teaching and learning, a widespread trend has seen a range of administrative functions move online in various ways. Examples include application, course/examination registration, fee payment, library services and student/faculty purchasing. This e-administration is positioned as key to e-learning development, providing more flexible and in-depth access to information and day-to-day processes and transactions. To emphasise the inter-dependent agenda, at the University of British Columbia e-administration or e-business development is one component of an all-encompassing e-strategy (see Box 2.1). While some respondents claimed that all or the vast majority of academic and commercial transactions could already be completed online (*e.g.* Open University Catalunya, Monash University), and a few were in the very early stages (*e.g.* Aoyama Gakuin University, Kyoto University, Multimedia Kontor Hamburg), most institutions were in the midst of long-term efforts to gradually shift to e-administration, and integrate a wide range of administrative and academic systems. Accessibility and integration often focused on portal development (see above).

Some institutions offered details of e-administration functionality. For example, the University of British Columbia respondent provided a detailed list of e-administration functionality aimed at students. This included online application (93% of applicants said to apply online), check application status, register for/withdrawn from classes, pay tuition and other fees, apply for financial aid, vote in student elections, request transcripts, change email address/password, manage housing/meal plan accounts, and book parking spaces. A common pattern was for an in-house student information system

to sit alongside third party human resources and finance systems (typically from Oracle, PeopleSoft[5] or SAP). The University of South Australia library system allows users to reserve books, order cross-campus/inter-library loans, renew books, set up journal alerts and receive electronic articles by email. While most e-administration systems were commercial or institutional in scope, the University of Paris Nanterre respondent cited use of a national student information system, APOGEE (Application pour l'organisation et la gestion des enseignements et des étudiants).

Presently, key barriers to ever-greater e-administration include hard-copy provision of supporting documentation (*e.g.* proof of English language competence), and limitations of particular legacy systems. For example, the Open Polytechnic New Zealand respondent stated that the version of institution's current LMS and the in-house student database prevented online payment. The UK Open University said that by 2005 all students would be required to engage with online administration, raising important questions about accessibility.

As an aside, the Carnegie Mellon University respondent mentioned work to re-write the in-house student information system (part of a future integration plan across all institution's systems). The current version of the system was described as "class centric" and "faculty centric", whereas the aim for the re-write was a "student-centric" system. This was in order to meet the challenges of disparate time schedules and locations for e-learning. This will allow the "normalisation" of a range of non-traditional arrangements such as short classes taught outside the standard semester structure, and "mastery learning designs" that encourage students to be enrolled in class for as long as is required for them to demonstrate mastery of the subject.

The Observatory survey asked whether "e-commerce facilities" (*e.g.* student/faculty purchasing and payment online) was currently in place institution wide. This question was somewhat limited in scope compared to the OECD/CERI survey question, but offered the closest approximation. Only 20% of respondents answered in the affirmative, with 22% predicting implementation within a year, and a further 29% within five years. This concentration of responses in the "middle" (*i.e.* implementation planned within up to five years) is in agreement with the OECD/CERI data. Thirteen per cent cited "local" e-commerce activity, and 14% said that this area was currently not a strategic priority. Similarly, a study of over 200 universities in Europe found that just under 20% of respondents cited such things as online course/examination registration as in place across all programmes;

5. In late 2004, Oracle purchased PeopleSoft.

with about another third saying this was available in some instances (PS RAMBOLL Management, 2004, p. 38).

The use of online applications for administrative purposes has and will probably continue to become increasingly common. It is currently supplementing rather than substituting for traditional procedures.

4.7. Integration of academic and administrative systems

As the range and scope of academic and administrative software has proliferated (typically involving both in-house and third party solutions), inefficiencies arise where different systems are unable to communicate. A recent trend has been for institutions to attempt to integrate disparate systems, or replace certain systems with a single, more comprehensive application (*e.g.* implementation of an Enterprise Resource Planning (ERP) system – see below). Integration offers an opportunity to rationalise legacy systems,[6] and to formally consider how each system relates to the others, and how any consolidation/integration might affect different stakeholders (Duncan, 2004). Almost all respondents described integration initiatives or plans. At one extreme was the Open University Catalunya, where the respondent simply stated that academic and administrative systems are "completely integrated". This once again was explained by the relatively recent creation of the Open University Catalunya as a dedicated virtual university.

Aside from obvious factors such as longevity of any integration project, extent of in-house system development appeared to be a positive variable (*e.g.* integration may be built into a range of applications from the outset), rather than needing to contort a range of third party solutions to work together. Rather than attempt to adapt in-house/legacy systems, some institutions (*e.g.* Asian Institute of Technology) have purchased ERP (Enterprise Resource Planning) systems. ERP systems (essentially use of a single database to integrate/replace independent legacy systems) can provide an overarching structure for integration efforts, although many systems are not optimised for use in tertiary education. Cornford and Pollock (2003) provide a detailed account of the misalignments between generic ERP systems and higher education institutions, and pressures on the latter to articulate and adjust structures and processes to conform. The authors argue that the tendency for institutions to bargain collectively for procurement

6. A legacy system refers to a computer system or application programme which continues to be used because of the prohibitive cost of replacing or redesigning it and despite its poor competitiveness and compatibility with modern equivalents. The implication is that the system is large, monolithic and difficult to modify.

purposes may exacerbate this standardisation/conformity trend. Some OECD/CERI sample institutions, having surveyed third party offerings, opted to develop in-house (*e.g.* UCLA Extension). The steady development and dissemination of various open standards relating to e-learning and education more generally (*e.g.* IMS enterprise standards) has been central to integration efforts, although specifications, coverage and adoption are far from complete. The University of British Columbia respondent said that lack of well-developed technical standards for single sign-on had been a particular challenge; and that delay in provision of this functionality often proved a major obstacle in terms of successful adoption of integrated systems.

Respondents set out a number of benefits of integration, including greater efficiency in terms of information management (from the perspective of students, faculty and staff), improved data integrity, reduced paper costs, a finer-grade view of accounts and self-service access to core systems. One commentator argued that integration arms unit leaders with enhanced adoption/impact information. "Successful convergence means library and IT leaders can more effectively justify ever-rising expenditures to an institution's financial and administrative leaders" (Duncan, 2004). Cited drawbacks included the time and complexity of adapting non-higher education systems to a higher education context, time and budget over-runs and staff resistance to new systems. The Asian Institute of Technology initially used an external consultancy to implement its ERP system, but then moved the entire operation in-house. While this resulted in higher internal costs, experience suggested the limitations of external consultancy (notably the consultants' lack of familiarity with a higher education context, and the internal effort required to re-configure/re-write retained legacy applications). One respondent indicated that integration had not been attempted on the insistence of senior management who feared that integration would compromise security (*i.e.* would make confidential information easier to obtain on an unauthorised basis). The respondent implied that such a view demonstrated an inadequate understanding of IT systems and security. The Open Polytechnic New Zealand respondent listed five separate academic/administrative systems and plans over the next three years to reduce five to an integrated two (that from the user perspective would appear as one). The two were identified as a learning environment and a student management system. The shift to Moodle from Online Campus/Blackboard was key to the former.

The Observatory survey asked about both compliance with emerging international interoperability standards, and integration of academic and administrative IT systems. Only 11% of respondents asserted that their IT systems were currently compliant with the relevant emerging international

standards. This low figure is partly the result of the fact that such standards are, in many cases, still under development, and (as in the case of single sign-on mentioned above by Carnegie Mellon University) some areas are even further from agreement. There may also be cases of rival interoperability standards. Forty-one per cent of respondents predicted compliance within up to five years (and 18% cited only "local" or limited compliance), but 30% said this area was not currently a strategic priority. The question cited SCORM and IMS (see Chapter 3) as examples of interoperability standards specifically concerned with e-learning. If one considered standards adoption across IT in higher education as a whole (both formal and de facto standards), then levels of compliance would be much higher (although not uniform in detail).

Was interoperability compliance in line with systems integration? A greater proportion of respondents (25%) claimed to have already effected systems integration institution-wide (compared to only 11% who claimed compliance with international interoperability standards). This suggests that some institutions have pursued integration by means of proprietary standards. Indeed, a number of respondents cited institution-wide systems integration alongside little interest in international interoperability standards. Sixty-one per cent of respondents pointed to systems integration within up to five years. Only 8% of respondents cited no strategic interest in systems integration. The disparity between rates of systems integration and compliance with interoperability standards may also partly be explained in terms of some respondents perhaps taking an overly narrow definition of "international interoperability standards".

4.8. Computer/network access for staff and students (Questions 3.1-3.5)

Computer and network access are prerequisites to e-learning. Case study institutions were thus asked about the institutional provision of computer/network access for faculty and students (both within and outside the institution), and (in respect of students) the balance between labs, portable computers paid for or facilitated by the institution and computers owned by students. These questions did not concern policies on how students/faculty use computers (*e.g.* etiquette and confidentiality).

Policy on computer ownership

All responding institutions reported at least a large majority of students owning (or with access to) personal computers (with Internet access), and none reported access to such hardware to be a significant problem. However, the vast majority of sample institutions did not mandate student computer ownership,

largely on cost grounds. For example, the Asian Institute of Technology respondent indicated that at present it would be unrealistic to expect every student to be able to afford to buy a personal computer (at the time of the survey about two-thirds of students at the institution were said to own computers). Some institutions operated leasing schemes, offering students an affordable alternative to personal ownership. The Asian Institute of Technology attempted such a scheme but was hampered by lack of interest from vendors. This respondent cited broadband connections in dormitories and the availability of ever-lower cost computers as the key drivers of independent student purchase, and predicted that within a few years all students at the Institution would own a personal computer. Without exception, all sample institutions reported 100% full-time faculty access to personal computers (*i.e.* a dedicated computer per faculty member). Access for part-time faculty might involve use of shared facilities. Only one institution (Monash University) mentioned threshold standards on minimum IT competency for staff (and plans for faculty).

The only sample institution to require computer ownership by students was the Virtual University of Tec de Monterrey. The respondent provided the detailed specification designed to guide student purchase (*e.g.* processor speed, capacity of hard drive, screen resolution, Internet speed, etc.). While the Open University Catalunya did not formally require students to own computers, the reality was that all students did own such a machine (or at least had access to one), and taking an Open University Catalunya programme would be impossible without such a facility. This was also the situation for most provision at the University of Maryland University College. The profile of the typical online student (working adult) was said to make computer ownership (or access through an employer) very likely.

At some institutions, particular faculties/departments mandated computer ownership. For example, the Graduate School of Industrial Administration (business school) and Heinz School of Public Policy at Carnegie Mellon University required every student to own a computer. At the Open Polytechnic New Zealand, from 2005 all bachelors business students will be required to have access to a computer and the Internet, and some other courses are expected to follow suit. At the UK Open University, the University's 2002 policy on IT access stated that: "the assumption [is that in] 2005 … students have access to ICT for study". The document goes on to explain that some courses require computer access for study and assessment, while others "use ICT in such a way that occasional access is sufficient for a good learning experience, and while lack of access will inevitably entail a lesser learning experience, it should still be possible to pass the course". Another part of the policy states that "students will be required to use the Internet for administrative transactions by 2005". In 2004, all Associate Lecturers (part-time staff based remotely) were required to have access to a personal computer and to the Internet. Students taking the bachelor

degree in business at the Open Polytechnic New Zealand were required to have computer and Internet access. The respondent characterised this as indirect facilitation insofar as the requirement meant that students could use government financial aid to purchase a computer. Without the requirement, this would not have been permissible. Zurich University mentioned student access to bulk discounted hardware and software through special arrangements with vendors. No sample institution, or unit within a sample institution, specified the brand of computer students must purchase.

At Carnegie Mellon University, it was debated whether mandated student computer ownership should be a policy across the institution as a whole, but this was resisted on cost grounds. While 95% of student in fact do own a computer, it was judged unreasonable to make such a demand on the remaining 5% – who were assumed to not be able to afford a computer. Other reasons for resisting such a policy were lack of evidence (from other institutions) of the pedagogic benefits of mandated ownership (beyond user satisfaction surveys) and concern that to maximise educational value the specialist software required by many subjects would need to be loaded onto every computer. The Monash University respondent cited a federal government commitment to equity as inhibiting institution-wide mandated student computer ownership at Australian universities.

Not a single respondent to the Observatory survey reported a "formal policy mandating computer ownership by all students", and only six (5%) said such a policy was under development. Moreover, only 13 (11%) offered subsidies to students for computer purchase, and only one cited this as under development. In the United States 2003 Campus Computing Survey, only 5.4% of responding institutions said that computer ownership was required for all undergraduates. Thirty-nine per cent said ownership was recommended. For specific disciplines, the required figure rose to 12%. The predicted "required for all" figure for the academic year 2005/06 was almost 13% (Green, 2003, p. 13).

Student/computer ratios

Table 4.4 provides an overview of the ratio of computers to students at each sample institution. The table offers a sense of development over time (included predicted development), and compares the ratio concerning computers paid for/facilitated by (*i.e.* through an institutional loan or bulk purchase scheme) the institution, with the ratio when independently purchased student owned computers were included. For distance-only institutions, where students accessed materials from home/work, the first category (computer paid for/facilitated by the institution) often did not apply. Many respondents indicated that the data were not collected systematically, and thus that the figures given were estimates. Some respondents chose to express the ratio as a percentage.

Table 4.4. Computer/student ratio

Ratio	Computer paid for/ (Facilitated by the institution)			Computers paid for (Institution and students independently)		
Time period	**2000/01**	**2003/04**	**2006/07**	**2000/01**	**2003/04**	**2006/07**
Aoyama Gakuin University	1:3-5	1:2	1:2	1+:1	1+:1	1+:1
Asian Institute of Technology	1:3-5	1:3-5	1:5	1:2	1:1	1:1
Carnegie Mellon University	1:1	1+:1	1+:1	1:1	1+:1	1+:1
FernUniversität Hagen	-	-	-	-	"Most"	-
Kyoto University	1:21-50	1:21-50	1:21-50	1:21-50	1:11-15	1:3-5
Monash University	1:30	1:20	1:35	-	-	-
Multimedia Kontor Hamburg	N/A	N/A	N/A	1:3-5	1:2	1:1
Open Polytechnic New Zealand	N/A	N/A (but see above)	N/A	-	85%	Expected to increase
UK Open University	N/A	N/A	N/A	81%	89%	99%
Open University Catalunya	N/A	N/A	N/A	1+:1	1+:1	1+:1
Virtual University of Tec de Monterrey	1:21-50	1:6-10	1:3-5	1+:1	1+:1	1+:1
UCLA Extension	N/A	N/A	N/A	Unknown	vast majority	Unknown
University of British Columbia	1:3-5	1:2	1:1	1:2	1:1	1+:1
University of California, Irvine	1:16-20	1:6-10	1+:1	1:2	1:1	1+:1
University of Maryland University College	-	Vast majority	-	-	Vast majority	-
University of Paris Nanterre	1:120	1:65	1:25	unknown	unknown	Unknown
University of Sao Paulo	1:16-20	1:11-15	1:6-10	1:3-5	1:2	1:1
University of South Australia	1:21-50	1:16-20	1:11-15	1:21-50	1:16-20	1:6-10
Zurich University	1:150	1:75	1:21-50	1:2	1:1	1+:1

Source: OECD.

Table 4.4 indicates that student-owned computers were a significant source of first resort hardware in many sample institutions, and the trend was predicted to continue. For example, at Kyoto University, while the ratio for institution-owned/facilitated computers remained constant between 2000/01 and 2003/04 (and was predicted to remain so until 2006/07 – at least in category terms), when student-owned computers are factored in the ratio improves dramatically over time. Zurich University was a good example of an institution where institution-owned computers are far outnumbered by student-owned systems. There was also evidence that growing student ownership of independently purchased computers was permitting some institutions to reduce their holdings. At the Asian Institute of Technology and Monash University, the predicted ratio of institution-owned/facilitated computers in 2006/07 represented a decline compared to 2003/04, and was explicitly compensated for by predicted growth in student ownership. No campus-based institution declared a policy to eliminate computer labs, seeing an ongoing role in terms of convenience, last resort and access to restricted software. It was notable that the new west coast campus of Carnegie Mellon University had no computer labs at all, and required every student to own a laptop. As student ownership grows, the task for the institution is to provide network access (including in classrooms) for student-owned machines, and flexible access to appropriate software. The University of British Columbia respondent stated that the "current view is that personal computers are like other learning aids (*e.g.* textbooks, paper) and as such are the responsibility of students". This indicates a shift in perception from personal computing hardware as the responsibility of the institution, to it being the responsibility of the student (in terms of both purchase and maintenance). Insofar as it requires increasingly flexible access to ICT, e-learning may be driving this trend. There was no clear association between institutions with a low computer/student ratio and investment in e-learning.

Governments also play a role in the access issue. For instance, to secure access to the Internet, the French Ministry of Education, Higher Education and Research launched the Student Laptop Programme (September, 2004) in partnership with a set of private companies (hardware companies, telecommunication companies and banks). The scheme allows students to pay for a laptop with a Wifi card (credit facilities of one euro per day).

Among Observatory respondents, taking solely institution-owned/facilitated computers, only one institution reported ratios of one-to-one or better; and only a further 7% had attained a ratio of one computer for every three-five students. At 36%, the most common reported category was 1:6-10, with 1:11-15 and 1:16-20 constituting a further 33% of returns. When student-owned computers were included, almost all institutions

reported an improved ratio. Taking the average figures by category (*i.e.* the pre-defined ratio categories from one to nine), the overall average improved from 6 to 3.9, suggesting that student-owned computers make up a significant proportion of total available personal computing hardware. Asia-Pacific, Canadian and UK respondents exhibited a stronger improvement than low income/low-middle income respondents, reflecting the reduced purchasing power of the average student in low income/low-middle income countries. The Observatory survey did not request historical and predicted future ratios, ruling out an assessment of whether particular institutions (as some OECD/CERI sample institutions appear to have done) have or plan to reduce their holdings as student ownership grows.

Remote access

Most OECD/CERI respondents cited some form of remote network access for faculty and students (*e.g.* a remote access server or a VPN – Virtual Private Network – perhaps outsourced to an Internet Service Provider [ISP]). As one would expect, remote access was most comprehensive (in terms of services available) at dedicated/partial virtual institutions (*e.g.* Open University Catalunya, University of Maryland University College). Some institutions (*e.g.* Carnegie Mellon University) provided free dial-up remote access, with plans to move to broadband in the next few years (unless the market mainstreamed domestic broadband). Mainstream private broadband access was said to be already a reality in Japan. At the University of British Columbia, 20 hours per month of free dial-up access is provided. Citing data from January 2003, 50% of the University of British Columbia students were reported to have personal access to broadband.

The VPN approach solves the problem of log-in access determined by user domain name (*i.e.* a VPN provides remote users with authenticated "insider" status). Alternatives include use of person-based (rather than domain-based) authentication, or use of inter-institutional authentication (*e.g.* the Shibboleth protocol). The Carnegie Mellon University respondent reported problems with remote access to a particular LMS (*i.e.* the authentication structure would not operate across the corporate firewall). An example of person-based authentication was cited by the UK Open University. SAMS (Student Access Management System), an in-house development, permits remote access by students by means of a unique identifier and password structure. For a number of institutions, a longer-term vision was to enable secure remote access to an institution's entire network from any location worldwide (*e.g.* to accommodate travelling faculty and remote students). This was particularly important to regional institutions

such as the Asian Institute of Technology. Remote access to an institution's network is a key part of the systems integration agenda described above.

4.9. Strategy on electronic journals and e-books

Alongside the development of online library support and advice services, all sample institutions reported growing acquisition and use of electronic journals, and to a lesser extent e-books. In general terms, notably in science, technology and medical fields, electronic journals, both due to lowering of publication barriers and streamlined delivery, have greatly increased the availability and range of titles. Major electronic journals publishers, such as Emerald, allow institutional consortia to bulk buy numerous titles at much reduced cost. There are examples of multi-institution, multi-publisher deals, such as those brokered by national organisations such as the Joint Information Services Committee in the UK (see National E-journals Initiative: *www.nesli2.ac.uk*). At Monash University, it was reported that about 60% of library usage now took place electronically from outside the institution. Many respondents cited the currently limited range of e-book titles as a major reason for minimal take-up to date. The main rationales for electronic journal adoption were cost and space savings compared to paper-based equivalents, accessibility, functionality and the desire to increase the number of titles available. The UK Open University respondent argued that while online journal acquisition was primarily driven by faculty research, this meant that such resources were available at a distance to remote students for the first time. This was said to "open up new pedagogic models which closely match the independent resource based learning which students at campus universities undertake".

Hard copy journal acquisition was widely reported to be in decline (specific figures not provided), with purchase of hard copy books generally stable or on the increase. At the University of British Columbia, to reduce costs and widen access, there was a policy to move in the direction of online only journal subscriptions "where a reliable, stable and up-to-date online version exists". At the University of South Australia, the library did not initiate a print subscription if an online version was available unless there was a strong case made by the relevant school/research centre. Moreover, the library preferred to acquire e-book only versions of in-demand titles. Alongside this, the Multimedia Kontor Hamburg respondent asserted that many publishers bundled print and online versions together, making it difficult to purchase only one or the other. Thus at this institution the practice was to offer online journals in addition to the print versions (with a planned shift to online only from around 2008 as and when publisher models change). Some institutions set out a vision dominated by online resources,

while others saw print and online as complementary. For example, the Carnegie Mellon University respondent outlined a strategy to create a "predominantly digital library", while at the Open Polytechnic New Zealand e-books were viewed as first and foremost a resource for students unable to access print copies. Even a virtual university such as the Open University Catalunya reported use of printed journals and books (housed in local support centres). The University had a policy of making some form of abstract available electronically to give remote students an indication of the contents of the item. By contrast, the Virtual University of Tec de Monterrey had no hard copy library at all. Evidence of the staying power of printed books came from the University of Maryland University College's book delivery service to students in the United States and faculty members worldwide. The University of Maryland University College was also experimenting with an equivalent e-book service.

A number of respondents cited notable initiatives in this territory. The Carnegie Mellon University respondent described the University's hosting of "The Universal Library". This was an attempt to preserve and disseminate the world's knowledge in digital form, with an initial target of one million books (Million Book Project). The work is funded by the National Science Foundation in the United States and by a number of companies and foundations. Various universities in India and China are responsible for scanning, indexing and hosting activity. The Carnegie Mellon University is also a founding partner of the "Text Archive", an initiative announced in December 2004 by the non-profit Internet Archive, and also involving the US Library of Congress, the Canadian universities of Toronto, Ottawa and McMaster, China's Zhejiang University, the Indian Institute of Science, the European Archives and Bibliotheca Alexandrina in Egypt. The "Text Archive" will pool a number of existing digital book archive initiatives, including Carnegie Mellon University's Million Book Project. The alliance followed Google's digital book archive partnership with the universities of Oxford, Harvard, Stanford and Michigan, and the New York Public Library. Both initiatives aim to make as much material freely available as possible.

The Virtual University of Tec de Monterrey is part of Tecnológico de Monterrey's (the parent institution) "Biblioteca Digital" (Digital Library) scheme, whereby the 33 physical campuses of the university formed a consortium for the purchase of electronic books and journals. The Digital Library has mainly purchased bundled subscriptions from major publishers/aggregators such as Emerald and netlibrary, rather than individual items direct from publishers. At national level, the New Zealand National Library has organised a similar scheme called EPIC (*www.epic.org.nz/nl/epic.html*). EPIC is a non-profit consortium established to enhance access to e-resources for all New Zealanders and to negotiate and

facilitate access to quality e-resources for library and information organisations and their customers. EPIC has negotiated nationwide licences with EBSCO and Gale (two major global e-content aggregators). Every person in New Zealand will be able to access the electronic resources via a "New Zealand Library", covering 171 libraries in all, comprising 94% of the country's tertiary libraries, 91% of public libraries, 32% of New Zealand's special libraries. All registered New Zealand schools are eligible to participate, and the Open Polytechnic New Zealand is a participant. The new "Libraries Australia" is a similar initiative.[7]

A number of institutions have developed some form of electronic repository to archive faculty research papers. For example, Monash University has an "e-press repository". There was said to have been little faculty use to date, but further promotion was planned. Many institutions (*e.g.* University Sao Paulo) now encourage online archiving of masters and doctoral theses. UCLA Extension has an arrangement with Xan-Edu, a commercial repository of over five million items of popular and scholarly research, plus videos and graphics. Faculty are able to recommend particular items for students to access, and students have the option of taking out a blanket subscription to the entire resource. At the UK Open University, it was now policy to produce all learning materials in e-book format as well as print.

Some respondents identified concerns and issues. One present problem associated with online journals was replicating norms of inter-university access. The Carnegie Mellon University respondent noted that in the past faculty and graduate students had been encouraged to utilise the holdings of neighbouring libraries. With the advent of electronic journals/e-books, licence agreements or authentication requirements were said to have effectively barred this practice. Cross-institutional or national agreements ameliorate this tension.[8] Another problem seen to be a result of expanded electronic access to library-type resources was said to be a trend for students to rely more heavily on "short articles rather than extended texts". The Open Polytechnic New Zealand respondent sounded a note of caution concerning the role of aggregators such as EBSCO and Emerald. At this institution, subscription to a hard copy journal was only stopped if an online subscription had been arranged directly with the publisher. The institution was wary of cancelling print subscriptions when electronic access was only available through an aggregator (which might drop a particular title from its "bundle"). The Virtual University of Tec de Monterrey respondent identified

7. *www.nal.gov.au*

8. Conyers, A. and P. Dalton (2005), NESLi2 – analysis of usage statistics (summary report), JISC. URL: *www.jisc.ac.uk/uploaded_images/jiscnesli2summaryeb.pdf*. Last Accessed: 12 May 2005.

the need for more "local" content, such as Spanish titles. The institution plans to contract with a vendor to digitise in-demand items.

There was some evidence of a blurring between journals/books and electronic learning materials, the ease of integrating online items into e-learning provision, and a growing role for the institutional library as a generic repository/gateway for materials in the broadest sense. A large majority of respondents to the Observatory survey (73%) cited substantial investment in campus library access to online journals and e-books, and only three did not see this area as a strategic priority.

4.10. Conclusion

This chapter rounded up a range of activities that support or complement e-learning in tertiary education. Among OECD/CERI case studies, most gave the impression that IT networks and bandwidth were more than keeping pace with e-learning demands, although the broader sample captured by the Observatory survey revealed widespread plans for urgent upgrades. Expanding network access/reliability, rather than first and foremost developing the network itself, were common strategies.

Portal development and systems integration generally are key trends to attempt to rationalise and consolidate disparate academic and administrative systems and information. At most institutions, such developments are very much "in-progress", with the role of in-house versus commercial applications and adoption of emerging open standards still being unclear variables. The portal may subsume the LMS, or the other way round; and this area has yet to see the vendor dominance characteristic of the LMS in tertiary education.

Data on student/computer ratios suggests a growing role for the student-owned computers, with some institutions strategically reducing their holdings. Few institutions cited plans to mandate student ownership (even at programme level), and one of these pointed towards student access to government funds as a key enabler. Electronic journal adoption was ubiquitous, although issues remained at long-term title availability online and license restrictions. E-books were less common, although a number of respondents were involved in major national/international digitisation initiatives.

Nevertheless LMS adoption is clearly one of the most prominent features of e-learning development in tertiary education worldwide. Both the OECD/CERI and Observatory surveys found widespread adoption, with trends towards institution-wide implementation and consolidation in favour of the two leading commercial vendors, Blackboard and webCT. Notably

among dedicated virtual and mixed mode/distance institutions, use of in-house/open source alternatives was more common.

Does in-house development signify valuable institutional autonomy over processes that are increasingly at the heart of instruction, or wasteful duplication of effort? Are leading proprietary systems pedagogically restrictive (as the backers of open source rivals such as Sakai and LAMS claim), or is informed use of increasingly vendor-neutral tools the key factor? Alongside widespread LMS adoption at institutional level, both surveys revealed only limited impact in the classroom. One study concluded that relatively limited usage of an LMS should not be dismissed as evidence of lack of innovation. Basic functions such as distribution of required readings or posting of assessment results "could signal an adaptation to a more fundamental change in how students prefer to get access to course materials, which could have dramatic implications on the geography of access, such as where students study and the global audience that could be reached by a single instructor" (Dutton *et al.*, 2004, p. 146). It is important to emphasise the relative novelty of the LMS as a mainstream product, and allow innovation to emerge in stages over time. Institutions still face key questions concerning how LMS-centric content development and administration is undertaken, notably the balance between local autonomy and institutional quality/consistency. Hopefully answers will emerge over time.

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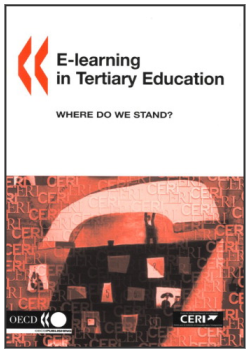

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