SeLeNe Report: Existing Learning Management Systems and Learning Object Repositories

Kevin Keenoy and George Papamarkos
{kevin, g.papamarkos}@dcs.bbk.ac.uk
Birkbeck College
University of London

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1 Introduction

Learning Management Systems (LMS) are systems that support the creation (via authoring tools), storage (for example in a relational database) and presentation (often via a web browser) of learning materials in a structured way. They often also include 'tracking' tools that allow for record-keeping on students enrolled in courses, and usage statistics for the system as a whole (one of the most important of these being statistical analysis of students' responses to questions, which enables validation of testing on the system).

Learning Object Repositories (LOR) are collections of learning resources with associated metadata, generally available and searchable via the Web.

LMS are usually designed to deal with learning objects at the 'course' level of granularity, whereas LOR tend to operate with much smaller units – generally individual web pages, multimedia objects (images, video, etc.) or programs. The 'courses' dealt with by LMS are an aggregation of the kinds of object found in LOR.

Both LMS and LOR are relevant to the SeLeNe project as SeLeNe will encompass elements drawn from them – the authoring support of a LMS with the storage and search facilities of a LOR. There are many LMS and LOR in existence, and the collection presented here is by no means comprehensive. However, we believe that the collection here gives a fair picture of the state-of-the-art of LMS and LOR at this time.

2 Learning Management Systems

2.1 Blackboard

- *The System*

  Blackboard claims to provide "a total e-Education Infrastructure" for schools, colleges, universities, and other education providers. The system can be installed locally at an institution, but they also offer remote hosting of courses on their own servers. As well as content management it provides various facilities including a bulletin board, calendar, active conferencing and quiz tools.

- *Licence*

  Blackboard is a commercial product – annual licences can be purchased for an installation locally (£4,400 for the Basic Edition, £15,000-£37,000 for the full learning system – with actual cost depending on the number of students at the institution), or a remote ASP hosting service can be bought.

- *Technology*

  Blackboard runs on relational databases and they claim it can be scaled to support tens of thousands of users by means of a multi-server configuration. It has a basic 3-tier architecture (Database back-end, Web Server in the middle and Browser at the front). For a local installation it appears that Sun Solaris and Red Hat Linux are the only platforms supported.

  The latest release of Blackboard supports SCORM specifications and sharable content objects by including a 'player' for SCORM objects. However, this does not mean that metadata specifications are necessarily adhered to - just that imported objects that do have metatdata can be used in the system. Content authors do have the option of adding metadata to their objects, but it seems that often this consists of just a free-text description of the object. There is support for IMS metadata specification to allow for IMS compatibility when content is imported and exported, but its use does not seem to be particularly encouraged by Blackboard.

- *Content Management*

  The import and export of content seems to be easiest at the 'course' level of granularity - entire courses can be zipped and unzipped as packages quite easily.

  Since January 2002 there has also been support for content exchange at 'Content Module' granularity via Prometheus - an open source software platform acquired by Blackboard. Prometheus allows the import and export of coherent modules to and from courses. It also enables the creation and modification of these modules by adding content to and removing content from a module. Modules can be shared with other instructors at the same institution (so only one copy of the module needs to exist in the system for it to be used in several courses), and can be transferred to other institutions, if the creator of the module chooses to do so. However, no mechanism seems to exist for the sharing of modules openly between instructors either within or between institutions, and hence there is no way to search for existing content.

While user-created content can not easily be shared or searched, publisher-created (i.e. commercial) 'course cartridges' are held in a searchable repository and can be downloaded (usually for a fee) for inclusion in courses. The cartridges must have some metadata associated with them in the repository as they can be can be searched by Discipline, Author, Title/Keyword, ISBN, and Publisher. However, this metadata does not conform to any standard specification.

Amending Blackboard courses once published (e.g. adding a page of content or changing a question on a test) is very difficult, and often the easiest method is to rebuild the whole learning path (a component of a Blackboard course) over again.

Student log-in is done by single-sign-on integration with an institution's existing authentication protocols - they claim it will work with SITS, Capita, SCT, PeopleSoft, Datatel, LDAP, Kerberos, as well as any other custom or proprietary system.

- *Search*

  All courses offered by an institution can be searched in a 'course catalog' available at the main Blackboard portal page at the institution. Users can search for courses via keyword or browse by category (the categories of courses are set by the system administrators).

  Once within a course there doesn't seem to be any support for searching the course material itself.

- *Personalisation*

  There is no personalisation of the learning experience – the system remembers which courses a user is registered for but that seems to be all the personalisation that is done.

- *Event Notification*

  Courses can be changed by authors as they are running. There seems to be no automatic notification mechanism within the system for when this occurs.

- *Future Development*

  Future development of the system seems now to be in the hands of the users themselves – since the introduction in December 2000 of the 'Building Blocks' programme any user can build their own application extension and distribute it through the Blackboard repository of 'Building Blocks'. Users can pick and choose which features they want in their system from existing building blocks, or can build their own if a suitable one is not available.

  Examples of currently available building blocks include a science toolkit (mainly mathematical calculation tools), dictionaries, a link-checker for course authors to validate external links, content authoring tools, collaboration tools and the SCORM compliant player mentioned earlier.

  This open development should ensure that Blackboard will keep abreast of developments in technology and e-learning systems.

2.2 Future Learning Environment (Fle3)

- *The System*

  Fle3 is server software for computer supported collaborative learning (CSCL). It supports learner and group centered work, enabling and encouraging collaboration and communication between learners taking the course.

  The learning environment consists of:

  – A "WebTop" that holds items much like the Desktop in Windows. Users can store and organise objects (documents, files, links) here. There is a shared 'course folder' that any user can access, alowing the sharing of resources between learners. The website says that "the items in the WebTops can be called learning objects - if you wish".

  – "Knowledge-building tools". These are tools that allow communication, discussion and debate among members of the learning group – basically notice boards that users can read and post messages to.

  – "Jamming" area — this is a shared space where digital artifacts (pictures, text, video, audio) can be constructed collaboratively. There is version control, and all past versions of the object can be seen in the space.

  Although the system could be used to manage and deliver course material in the same way as WebCT or Blackboard the emphasis is much more on encouraging learning through debate and collaboration. Rather than providing a whole set of course material, teachers are more likely to populate a course environment with a few 'starter' objects and a couple of topics for discussion, and let the learners themselves develop the workspace.

- *Licence*

  Future Learning Environment is free, open source software released under the GNU GPL.

- *Technology*

  Fle3 is a Zope product (Zope is an open source application server), written in Python. Zope and Fle3 run on GNU/Linux, MacOS X, *BSD, and Microsoft Windows.

  As the focus of the system is on providing tools for collaboration, rather than on content development and management, no metadata is used to describe objects - they are just shared 'as is' between learners on a course.

- *Content Management*

  For teachers and administrators Fle3 offers tools to manage users and courses/study projects. The administrator may also export and import courses or the entire content of the Fle3 database in XML format (compatible with the Educational Modelling Language - EML).

  There is support for the collaborative development of resources for use by a learning group provided by the 'Jamming' tool, but teachers must create their own resources outside of the system and add it to the shared folder of the WebTop if they wish to provide content themselves.

- *Search*

  There seems to be no support for search in Fle3 – either within a course or for material between courses.

- *Personalisation*

  There is no direct support for personalisation of the individual learning experience. However, the system is open source, so the interface and functionality can be customised by users.

- *Event Notification*

  There is no notification to users of changes to the learning environment - it is up to them to explore and find new material as it is added.

- *Future Development*

  No details of future development plans are available, but as the project is open source it may be up to the users which additional features are added to future versions of the software.

2.3 .LRN

- *The System*

  The .LRN (dot LRN) is a portal framework and integrated application suite developed at MIT that supports course management and online learning communities with personalised content

  The .LRN is based on a modular architecture that permits flexibility to merge a variety of technologies. It is based on the Web Services paradigm, permitting horizontal integration of both open source and proprietary technologies.

- *Licence*

  .LRN is a fully open source e-Learning platform. The .LRN is being made available as open source software under the GNU General Public Licence (GPL).

- *Technology*

  .LRN has a strong relationship with some of the best research and technology initiatives at MIT – including Open Knowledge Initiative (OKI), DSpace and iCampus.
  The development of the system is based on two basic components:

  – AOLserver – the open source web server of AOL
  – OpenACS – a powerful web toolkit for building highly-scalable database-backed web sites[1].

  It is also compatible with Oracle and PostgreSQL, a powerful web toolkit for building highly-scalable database-backed web sites.

  Currently the .LRN is in beta condition and does not fully support any metadata standard. It is planned that the first stable version of the platform is programmed to be fully compatible with IMS and SCORM standards. At the moment there is only partial support for the IMS System – the IMS Content Packaging System is used for data transfer across the network in the form of XML.

- *Content Management*

  Authentication

  The authentication system of the .LRN is based on the classic login system. Users send a request for registration on a course to the system administrator. Once the user is approved and registered an e-mail address and password must be submitted for log-in. This is done at a secure web page in order to ensure password security. The system does not remember any passwords.

  Material Management

  The .LRN is characterised by flexibile resource management and there are many types of resource material available. There are user groups organised into classes of interest and communities which share information about specific events and information.
  The user is able to register for events of interest using a calendar (daily, weekly and

[1] OpenACS is developed by a world-wide community of experienced web hackers who are committed to building a solid, fully open-source web platform.

monthly), and can store personal files and bookmarks in their space on the system. They can also submit homework or coursework for a course – the submission is timestamped.

As well as the characteristics above, teachers also have access to a 'control panel' where they can manage memberships, subgroups, calendar events and all methods of communication with students. The control panel can also be used to access tools to create new items, surveys, FAQs and to send bulk e-mail and homework notifications. The teacher is responsible for modifying the content of the courses, publishing them to the Web and posting changes and news.

- *Search*

  The main method of navigation through available resources is to browse them by category. The resources are currently divided into three main categories: Interest Groups, Forums and News. Users can browse through the available categories and choose groups they are interested in to join. Currently there is no way to search by keyword or any other type of search. Later releases of the platform will probably support it.

- *Personalisation*

  One of the most impressive characteristics of the .LRN is its great flexibility in personalising the environment. Teachers as well as students are able to personalise their environment to a great extent.
  Through the "Control Panel" tab they are able to change almost any setting that concerns their account.
  The teachers are able to manage their classes and groups and fully customise the layout of the course.
  The students can join forums, courses or news groups that they are interested in, request change notification, store their personal files and maintain their personal calendar (monthly and weekly), which keeps track of their event transactions and much more.

- *Event Notification*

  The event registration and notification in .LRN is done by the use of a module. The event registration module is currently ready and has been tested. The final integration of the module is expected to be completed and be ready for use in February 2003.
  Users can also request notification via email of changes in the forums the user is interested in.

- *Future Development*

  The .LRN is currently in a beta state. The .LRN is a continually developing project, and by the time of the first official stable release new features and functionality will have been added. The enhancement process has been undertaken by a number of forums that work on one topic each. The areas subject to improvement or that will be added are:

  1. *Class Registration.* Enhanced expression of who should be in which classes/groups, in which role and what the joining criteria are. This can vary significantly from school to school and the tool needs to support individual specifications.
  2. *Chat.* A chat-room program to provide synchronous communication between users.

3. *Curriculum.* Enables sequenced traversal of branched learning activities in online courses. Curriculum will allow educators to arrange learning resources, such as documents and tests, into syllabi within a general curriculum.
4. *Events.* The full integration of the event module is expected in February 2003 (see above).
5. *Expansion of Survey Functionality.* Expansion of the current functionality to include scoring, sequencing and feedback.
6. *External Authentication.* An attempt to make login services of .LRN independent of Authentication Technologies.
7. *IMS and SCORM Standards.* Compatibility with IMS and SCORM metadata standards.
8. *Internationalisation of the OpenACS Project.* Add support for more languages.
9. *Archiving/Deleting Groups.* Provide a way to make old classes and communities in the system "go away".

2.4 MOODLE

- *The System*

  MOODLE is a software package for producing internet-based courses and web sites. It is an ongoing development project designed to support a social constructionist framework of education. The name MOODLE stands for Modular Object-Oriented Dynamic Learning Environment. It is a system that has been developed by a single man, Martin Dougiamas, as a part of his PhD Thesis. Its development started in 2001 and the current version of the platform is 1.0.6.4.

- *Licence*

  MOODLE is provided free as Open Source software under the GNU Public Licence (GPL). Basically this means that MOODLE is copyrighted, but that the user has additional freedoms.

- *Technology*

  MOODLE is built in PHP and can potentially support many types of database. Presently only MySQL is supported, but in later versions support is planned for PostgreSQL, MSSQL Server, Oracle, Access, Interbase, Fox-Pro, ADO, Subase and DB2. The web server used is Apache.
  MOODLE was developed in Linux but it is platform independent. The software required is a working installation of PHP (version $\geq$ 4.1.0) and a working MySQL database installation. The MOODLE system does not use any specific metadata standard beyond the metadata provided by the underlying RDBMS. The next main release should have some basic support for IMS and SCORM.

- *Content Management*

  Authentication

  The whole platform is based on a very good authentication system. It supports a range of authentication mechanisms through plug-in authentication modules. Students can create their own login accounts by e-mailing to the system administrator. Email addresses are verified by confirmation. Also LDAP can be used to check the account logins. SSL and TLS certificates are also supported.
  Each person has only one account for the whole system – each account can have different access rights. The administrators control the creation of courses and create teachers by assigning users to courses. Teachers (of a course) have full control over the course content – they are able to add an "enrollment key" to their courses to keep out non-students and can also unenroll students manually.

  Material Management

  Resource management is also very flexible. There are many course formats – they can be organised by week, by topic or as a discussion-focused social format. There is a wide array of possible course activities (including Forums, Journals and Quizzes). Recent changes to the course since the last login can be displayed on the course home page.

  Modification and authoring of courses is done by the teacher. Students can upload their assignments to the server and send their feedback on some topics that the teacher allows.

- *Search*

  The contents can be searched by keyword or be browsed by course. Structured search is not yet supported.

- *Personalisation*

  Users are able to edit their own profile. This includes subscriptions to forums and watching courses. The capacity for personalisation of the environment is subject to be improved further in the next main release of the product.

- *Event Notification*

  MOODLE does not support event notification in the form of active rules. The only event notification mechanism that exists is PHP script that runs periodically (e.g. through the program `cron` in Unix systems), checking the resources for changes and then notifying interested subscribers by sending an e-mail, for example to the subscribers of a mailing list.

- *Future Development*

  The next main release of MOODLE is expected to include some major new features such as :

  1. Stronger pedagogy support for both teachers and students.
  2. Support for groups and groupwork.
  3. Rewritten display incorporating XML, XSL and CSS.
  4. Basic Support for meta-data standards IMS and SCORM.
  5. A variety of new modules such as chat.

  In the future some pay services may be offered, although the software itself will remain free.

2.5 WebCT

- *The System*

  WebCT claims to be the leading provider of e-learning solutions to the higher education sector. It offers two main products:

  - 'WebCT Campus Edition', which is a course management system designed to be implemented across a higher education institution. As well as content delivery and management it includes student performance assessment and tracking and communication tools such as whiteboard, discussion forum and instant chat room.
  - 'WebCT Vista', which is described as an "enterprise-class e-learning system" – it appears to do the same as Campus Edition, but with a few extra features such as role-based authentication, an SDK to allow application extensions to be built, and additional functionality in the communication tools, allowing 'cross-course' communication.

- *Licence*

  WebCT is a commercial product, cost according to number of servers required (maximum 3000 students per server) and the actual products supplied. The cheapest 'entry-level' system costs £4,500.

- *Technology*

  WebCT can be run on a range of platforms, including Sun, Windows, UNIX, and Linux. WebCT Vista uses Sun Microsystems Enterprise Java Bean (EJB) technology and is J2EE compliant. The multi-tier architecture includes a BEAWebLogic application server and an Oracle 9i database layer comprising Oracle 9i DBMS (Database Management System) and Oracle 9 IFS (Internet File System). It uses IMS-compliant metadata to hold information about the learning resources (XML DTDs can be dowloaded from the WebCT website), and there is an IMS content-migration utility.

- *Content Management*

  Both editions of WebCT allow migration of content using an IMS compliant system (with data in XML format), but this does not allow searching for course material – it seems that the user needs to know that the content exists, then ask a system administrator to migrate it for them. WebCT Vista includes role-based access to content, which allows for ease of sharing within an institution (across course boundaries). It also allows direct sharing of content between different institutions, but only if they share a central installation of the WebCT software.

  Support for authoring seems to be focused at the course, rather than the learning object level. There is rudimentary support for the authoring of learning objects within the system (little more than a text editor), but learning objects (web pages that can include any embedded objects that HTML allows) can also be created outside of WebCT. The system interfaces well with external content creation packages, and Macromedia's Dreamweaver can be set up to automatically add and edit objects within a WebCT course. Authors need no special software to create courses from their existing learning objects - just a browser and a network connection to the WebCT server.

Access to course materials is restricted to users registered for the course, and course administrators can release materials gradually and selectively (e.g. only when a student reaches a certain level of attainment). If the institution's computer system uses LDAP or Kerberos based authentication then WebCT integrates directly with this, otherwise it has its own custom login protocol.

- *Search*

  The only searching that can be done for learning resources is via a Java API to the Oracle database at the institution (metadata fields can be searched to help locate useful resources), making location of new content difficult, and nigh-on impossible if the content is at another institution. WebCT do provide their own learning content ("e-packs") which is available from the WebCT website (if you are registered with them) and which can be searched using a simple keyword search tool.

  Within a course search facilities seem quite good – course authors can automatically create a searchable index of the material to provide students with search functionality. If the author chooses to do this then students can search the available resources (within a course) by keyword. A searchable glossary can also be created by course authors.

- *Personalisation*

  WebCT claims to offer "highly personalized educational experiences", but in practice this seems to be mainly at the institutional, rather than individual level. The 'look and feel' of the system can be tailored to reflect the institution's branding (e.g. by the inclusion of a logo). Course designers can then also modify the layout and colour schemes of material further.

  WebCT can provide personalised learning paths for users, as access to objects can be conditioned on a wide range of personal data including achievement, date/time and class code (i.e. there may be many classes taking the same course, with different materials available to different classes). In reality this is seldom used to any great extent due to the high cost of developing learning materials in different styles and setting up courses to use these effectively. Personalisation at the level of the individual learner is usually restricted to allowing users to set individual bookmarks and providing a single-sign-on system – i.e. the system knows which courses a user is registered for, and once signed in once all of these courses can be accessed without the need to sign in separately for each one.

  There would seem to be a lot more scope for individual personalisation than this, as the WebCT system records quite a lot of information on the behaviour of the users (which documents they visit, how long they spend viewing them, test results and grades). At present this information seems to be used solely for the production of reports, but could be used towards providing a truly personalised educational experience without the need for large investments of course designers' time.

- *Event Notification*

  There seems to be no event notification mechanism in WebCT - if material is added to or removed from a course it is up to the learners to find out for themselves. There is a 'News' section for each course, so the course administrator could choose to add a news

item or to send an e-mail to the cohort informing users of any changes made, but this is at their discretion rather than an automatic process.

- *Future Development*

  WebCT say they plan to incorporate more new technologies into the system and to maintain compliance with developing industry standards. The only example given is to add a SOAP web-services interface to the WebCT Vista SDK.

3 Learning Object Repositories

3.1 CAREO-Campus Alberta Repository of Educational Objects

CAREO (Campus Alberta Repository of Educational Objects) is a project supported by Alberta Learning that will create a searchable, Web-based collection of multidisciplinary teaching materials for educators across the province.

- *The Collection*

  The repository contains over 3000 varied multimedia objects such as video clips, images and electronic text books. Membership of CAREO is free and open to anyone. Members enjoy a variety of services including access to all sections of the site, personalised layouts and information delivery and Interactive Subscriptions Services. A guest login is also available for free, giving open access to the repository without submitting any details. Currently there is no difference in the access permissions of a member and a guest.
  The advantage of being a member comes from the ability to add objects and customise the CAREO site (see below).

- *Metadata*

  The metadata information is located into the so called metadata store which is structured according to the CanCore[2] Learning Object Metadata Protocol, which is based on the IMS LOM.
  CAREO uses the ALOHA (Alberta Learning Object Hub Application) meta-data markup tool as an aid for importing metadata to the repository. This is a java-based tool, which is accessible via the CAREO portal, that allows the user to drag-and-drop media onto it and hence publish it in the repository.

- *Learning Object Authoring*

  The ability to author new objects and personalise the view of the CAREO site is a privilege for the members only. The content of the site is dynamic so the view can change depending upon the level of access you have, the profile you have created for membership or the time you enter the repository. When you have an active membership to the system you can dynamically add and remove new objects to your view and modify some of the existing ones. Guests have no access to this feature.
  System administrators are able to modify the metadata and are allowed to change, update and modify the learning objects.

- *Search*

  The CAREO repository has a keyword-based search interface. This searches keywords contained in the 'Title', 'Description' and 'Text' metadata fields of objects within the repository. It is designed as a quick way to search through the repository content.
  Other search options include advanced search, which allows searching in other specific metadata fields, and browse objects, which allows drill-down searches of the entire contents of the repository.

[2]CanCore is based on and fully compatible with the IMS Learning Resource Meta-data Information Model. CanCore has defined a subset of data elements of this IMS model for the purposes of the CAREO project.

- *Personalisation*

  Members have full privileges for personalising their view. The users have the ability to store their notes about objects and create bookmarks on objects they find relevant (this is called 'subscribing to an object'), giving easy access to the same object in future once a useful object has been located in the repository. Through an option in the web site they can see the information about their account. Here the user can modify account preferences, the way they view the site and the way the site views them. They can create a profile that will allow the repository to identify the particular areas of interest and allow for content updates of relevant material and communities. Also the number of objects shown can be modified in the profile of the account.

- *Event Notification*

  CAREO does not notify all users of events that take place into the repository, but when an object changes its subscribers are notified that the object has changed via e-mail. There are also notification mechanisms via the web page or through the the use of WebCT, with which CAREO is integrated.

3.2 European Treasury Browser

- *The Collection*

  The European Treasury is a collection of learning objects that can be browsed on-line (at the European Treasury Browser). It is aimed mainly at schools in Europe, both for teachers preparing lessons and learners doing independent research. The project has partners in seven European countries, and the resources are in various languages.

  The aim of the ETB project is to build a Web-based Metadata Networking infrastructure for schools in Europe, to link together existing national learning object repositories, encourage new publication, and provide a reliable level of quality and structure. In this sense its aims seem to be similar to those of SeLeNe.

- *Metadata*

  Metadata is stored about the objects in the repository, but it does not seem to conform to any particular standard. The information stored is:

  - Title
  - Language
  - Description/Abstract
  - Audience (Teacher, Pupil, Higher Education, etc.)
  - Audience Age.

  The metadata is authored by whoever proposes the resource be included in the repository.

- *Learning Object Authoring*

  Anyone can suggest resources to be added to the repository from a page on the website. A minimal set of metadata must be supplied with any suggestion. There is no support for authoring new material within the system – it is simply a repository for material that has been produced elsewhere.

- *Search*

  The objects in the repository can be browsed by category and searched by keyword. There is also an 'Advanced Search' option, which is quite limited – it allows 'AND' and 'NOT' operators to be applied, and search within a particular target audience and age range. A more complex structured search across all metadata fields appears to be lacking though.

- *Personalisation*

  Support for personalisation is limited – the web site will remember how many results to return per page, and which is the user's preferred language.

- *Event Notification*

  There is no support for event notification at present.

3.3 MERLOT - Multimedia Educational Resource for Learning and Online Teaching

- *The Collection*

  MERLOT is a free and open repository of about 3700 resources, mainly for use by the higher education sector in the US. It consists of a collection of links to learning resources (mainly web sites), and each link is annotated with metadata including peer-reviews and pedagogic information.

  No registration is necessary to use the repository, but if users with to add objects and reviews then registration, which is free, is required.

- *Metadata*

  MERLOT uses metadata elements that map to the IEEE LOM, and the LOM data can be exported from the repository as XML (but only by a select few system administrators and partners – not by the general visitor to the site).

  There are future plans to implement a Web Service that will be able to search multiple collections at once (MERLOT and other partners), taking LOM input parameters and returning LOM XML (a subset of elements) as a result.

- *Learning Object Authoring*

  Registered users can add objects (or their URL's at least) to the repository as they see fit. These could be authored by the member themselves, but any web-based resource can be added. When a material is added by someone other than its author or creator, an email is sent to the person who owns it to let them know it has been listed in MERLOT.

  When an object is added it may be subject to a structured peer review and scored (out of five) in each of the categories Quality of Content, Potential Effectiveness as a Teaching Tool, and Ease of Use. If an object scores poorly in the peer review (below 3 out of five on average) it is removed from the repository.

- *Search*

  The resources in the repository can be browsed by category, searched by keyword, or searched by a structured 'advanced search' on various metadata fields.

- *Personalisation*

  There is no personalisation available in MERLOT.

- *Event Notification*

  There is no event notification mechanism in MERLOT.

4 Conclusions for SeLeNe

Weaknesses of existing systems:
The main point arising from this investigation is that almost without exception both the Learning Management Systems and Learning Object Repositories are very weak in two areas:

1. **Event Notification** – notifying users of the system when objects within the system have changed since they last interacted with it.

2. **Personalisation** – the personalisation that does exist tends to be either interface personalisation (what colours to use, how many search results to return) or authentication-related (showing only those courses/learning objects that the user is permitted to access). There is no personalisation in the sense of creating an individual learning experience for users by presenting only material that will be pertinent to their needs.

If SeLeNe addresses these two issues (as it plans to) then it will certainly be filling a 'gap in the market'.

Strengths of existing systems:
The multiple search interfaces used by most Learning Object Repositories seem to be a good thing – all of those we have seen allow browsing of the objects by category and also employ a keyword search. Most also have an "advanced search" option which allows certain specific metadata fields to be searched. This range of search options means that users can choose the kind of search that suits their search style, or that they judge is most likely to of use in satisfying a particular need. If SeLeNe implements other kinds of search it should probably be in addition to, and not instead of, the "browse, search and structured search" interfaces.

The ALOHA metadata markup tool (see CAREO) seems useful. Maybe SeLeNe should include something similar to allow learning object authors to easily mark-up the objects they create.

Other relevant projects:
One interesting development is the proposed integration of CAREO with WebCT and Blackboard. While this is only a proposal at present, it will be worth keeping an eye both on how this particular project progresses and on whether integration of LMS and LOR becomes more widespread in general.

The "LOM metadata metasearch web service" proposed for MERLOT is another development of relevance to SeLeNe in that it seems to be the only proposal for search that goes beyond the "browse, search and structured search from a web page" paradigm adopted by other existing Learning Object Repositories.

5 On-Line Resources

5.1 Learning Management Systems

Blackboard	http://www.blackboard.com
Future Learning Environment	http://fle3.uiah.fi/
.LRN	http://dotlrn.mit.edu/
MOODLE	http://moodle.com
WebCT	http://www.webct.com

5.2 Learning Object Repositories

Canada SchoolNet	http://schoolnet.ca	Over 7000 resources, metadata search.
CAREO	http://careo.netera.ca	*See report for details.*
EdNA	http://www.edna.edu.au	Education Network Australia.
ETB	http://etb.jrc.it	European Treasury Browser.
GEM	http://www.thegateway.org	Gateway to Educational Materials: Inktomi Search over 26,000+ resources.
Learning Matrix	http://thelearningmatrix.enc.org	Peer-reviewed LOR.
MERLOT	http://www.merlot.org	*See report for details.*
SMETE	http://www.smete.org	Uses LOM-based metadata.
UBP	http://www.educanext.org	Universal Brokerage Platform: Commercial repository with subscription at institutional level.

6 Appendix: Summary Tables

LMS	Event Notification	Licence	Metadata	Cross-platform	Keyword	Structured	Browse
Blackboard	No	Commercial	Not standard	Solaris/Red-Hat	No	No	Yes
Fle3	No	Free - GNU GPL	None	Yes	No	No	No
.LRN	Yes	Free - GNU GPL	IMS & SCORM	?	No	No	Yes
MOODLE	Yes	Free - GNU GPL	None yet	Yes	Yes	No	Yes
WebCT	Some	Commercial	IMS	Yes	HTML only, within course	No	No

Table 1: Summary of Learning Management Systems

LOR	Event Notification	Metadata	Personalisation	Keyword	Structured	Browse
CAREO	E-mail	CanCore (IMS)	Interest profile	Yes	Yes	Yes
ETB	No	Non-standard	No	Yes	Limited	Yes
MERLOT	No	IEEE LOM	No	Yes	Yes	Yes

Table 2: Summary of Learning Object Repositories