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Technology, Infrastructure, and Inter-Institutional Teaching and Learning Goals:

Toward the Development of Standardized Learning Management Systems

Group on Information Resources (GIR)
Learning Management Systems – Work Group Report

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GIR Work Group on Learning Management Systems

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Group Background and Purpose

In response to growing interest from members, the Group on Information Resources (GIR) organized a forum at the GIR Educational Technology Summit on January 10, 2008. This summit was designed for educational technology leaders from medical school and teaching hospitals to come together and begin a national conversation on infrastructure and technology standards around medical education technology. Three exploratory groups were commissioned to focus on three areas where availability of technology standards is limited and presents challenges to design, delivery, and sharing of content: virtual microscopy, efolios, and learning management systems (LMSs). From this summit, a group of participants volunteered to develop a best practices document on LMSs to support medical education.

The work group reported on its progress and continued discussion at the Group on Information Resources Professional Development Conference on May 2, 2008. A final report was presented at the AAMC annual meeting in November 2008.

This group discussed various systems and standards, how to share LMS-created content (lessons, quizzes, and exams), how to establish federated identities (fourth-year issues), and how to track competency and student expectations. The group also discussed how best to make the case for these kinds of standardized and integrated technologies.

Major discussion themes included how to access data across multiple systems, how to share LMS assets across enrollment years and institutions, and how best to meet the demand for collaborative and social networking tools. Schools felt that effective use of current LMS could be improved in part by policy changes within and across institutions. Thus, standardized, shared LMS capabilities and assets could then flourish in a way presently prohibited by the self-contained nature of many institutional policies and controls.

Emergent Discussions

The present working paper results from the collaboration of 15 members from different institutions around the country. This group, Learning Management System Group (LMSG), was asked to develop a best practices document on LMSs to support medical education.

When the LMSG first convened, it was given three specific principles to consider as part of its deliberations and ultimate recommendations for an LMS:

1. All students must retain access to all courses, including completed ones, for all four years of their medical schooling.

2. The LMS/content systems must integrate with a Medical Education Portal.

3. The LMS should support institutional collaboration, preferably via some technological solution that allows for team projects.

Introduction: Learning Management Systems (LMSs)

This paper defines *learning management system* as any software tool or system designed to deliver and manage course materials of various types (learning objectives, case studies, collaborative workspaces, multimedia, etc.) for user access, learning, interaction, reference, and collaboration. While each LMS offers different customizable options and variable aesthetics, most perform the same basic functions.

Learning Management Systems (sometimes called *course management systems*) are commonplace among U.S. medical schools. The field has boomed in the last 10 years, and LMSs are currently seen as an integral educational tool for students and faculty alike. Use of LMSs across education continues to grow, and, as a result, the systems are becoming more robust and flexible. LMS are an integrated suite of learning tools and services used in various ways at different institutions. Some common LMS features include:

- Course calendars
- Online course materials and resources
- Online self-assessment modules
- Discussion forums
- Wikis/Blogs
- e-Portfolios
- Search ability
- Communication tools
- Access control tools
- File storage

Most LMSs are Web-based, which helps facilitate anytime, anywhere learning. They permit flexible, secure access to course materials and tracking of student progress. Three major types of LMS platform include commercial (e.g., Blackboard, Angel), custom developed (university built), and open-source (Moodle, Sakai). Many schools use a combination of the above types (e.g., commercial LMS with custom-developed student modules and an open-source portal).

An LMS provides modules and tools that can enhance any curriculum without necessitating a particular pedagogical approach or method. For purposes of medical education in particular, an LMS must support multiple teaching modalities, and must support them simultaneously.

LMSs provide a variety of benefits for students, including easy access to course materials, multimedia, and discussion forums; ability to track learning competencies and enable collaboration and information sharing; and accommodate different learning styles.

Learning Management Systems Group Vision for the Future

LMSs content should be accessible from home, library, and institutional computers using any modern Web browser. (Ideally, it would also be compatible with mobile technology.) It should further be supported by sufficient IT and network resources so that students and faculty can make broad use of these technologies. Security must be kept up-to-date, and daily backups must be ensured. An after-hours help option should also be available.

The ideal LMS would contain all academic information, including course materials, assessments, digital course assets, enrollment, and grade data. It would be able to track student participation and competencies. It would also utilize the currently available collaborative, interactive, networking, and social tools of Web 2.0, such as blogs, wikis, and videoconferencing. While many schools seem to have

most of these available through a combination of multiple systems, no single LMS has been identified that includes all of these components. Furthermore, serious challenges to integrating the various components include hardware and software compatibility, identity management, interoperability among various platforms, and authentication policies. Persistence is another major issue. Technology changes so quickly that it is important to use technology that will likely be around in the long-term, so perhaps it would be profitable to understand the ideal LMS as a portal from which choices of tools, including third-party options, could be plugged in with pass-through authentication. Ultimately, the LMS would be transparent and fully integrated into the infrastructure of the entire educational system (e.g., access to grades, financial aid, etc.) within one password-protected logon.

Basic Principles

The working group was charged with focusing on the following three areas and, within those areas, was asked to consider access, security, support, persistence, and collaboration. The group's results are as noted below.

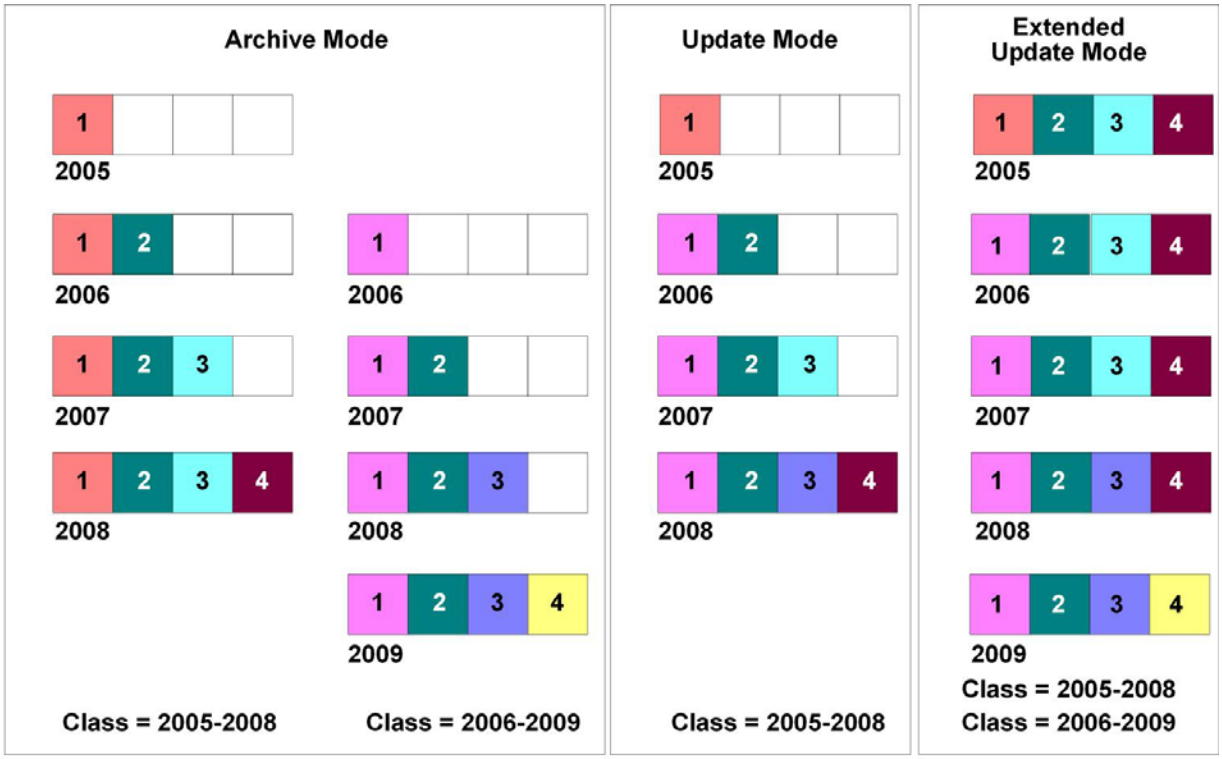
1. **All students must retain access to all courses they have already completed in medical school for all four years.** (Access in this discussion is defined as the ability to enter, participate in, or use materials associated with a course.)

Learning Management Systems should improve student learning experiences, accommodate a variety of different learning styles, and allow more effective teaching. As medical educators, we seek to graduate physicians with a lifelong learning habit. By allowing our students access to all the materials they encounter during their medical school curriculum, we foster self-directed exploration of future topics related to the current curriculum.

Access also permits students to revisit the science of medicine when it becomes important clinically. For example, in their clerkship years, students taking care of patients with increased ammonia levels may wish to revisit the relevant materials presented in their first two years on the urea cycle. We know that it is impossible to remember all the details that are part of preclinical teaching. By reviewing material previously encountered, rather than starting again with information presented in a different format, there is repetition to aid in retention.

Providing students access to course materials across the four years of medical school can be accomplished three ways. First, course material can be archived for the specific cohort (graduating class) of students so that the students have access to the course material that was provided the year the student was enrolled in the class. This mode will be called **Archive Course Mode** for purposes of this discussion. It is illustrated below in the two examples on the left: Archive Mode for Class = 2005-2008 and for Class = 2006-2009. This represents the material that is available for each cohort for each year of the cohort's study. One can see that each cohort has access to materials uniquely available to them based on their years of enrollment.

In a second mode, called **Update Course Mode**, student cohorts have access to the current year's course material for all the courses the students have completed and those in which they are currently enrolled. That is, students have access not to the materials that were unique to the years they were actually enrolled in the given courses, rather they have access to the materials that are being presented in the current year to the current students. In this way, all students have access to updated content in all courses.



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The third mode, **Extended Update Mode** (right column of the illustration), is similar to the Update Mode in that current materials are always available to students. It differs in that students have access to materials in future classes, not just current and completed classes. Although this mode offers a strong advantage in completeness of materials, the process and disadvantages are the same as the Archive Mode.

The purposes for allowing students to retain access to course material is to facilitate the review process for them and to promote collaboration and interaction through horizontal and vertical integration of student learning within the curriculum. The purposes for allowing students access to future materials are to promote familiarity with the broader context of learning, encourage self-directed learning, foster serendipitous learning, and reinforce vertical integration.

Archive Mode	Comments
Access	Student has access to the course that the student actually completed.
Process	The course and course material for a class are archived upon course completion.
Disadvantages	This mode does not provide updated content unless a process is implemented to keep the archive content current.
	Updating archived content can become problematic when significant areas of the course have been modified.
	The archived course material mode does not facilitate collaboration between current and past students, since the current course and the archive course are segregated.
Advantages	By segregating the current and archived courses, managing the release of sequenced content is alleviated.
	Assessments can be used as a review tool for past students and as an evaluative tool for current students.
	The current course can have content released on a schedule while the archived course can have all material available for review.

Update Mode	Comments
Access	Current as well as past students have access to the same course. Therefore, current and past students have access to the updated content within a course.
	Processes would need to be implemented that allowed past students to review all content regardless of release sequence.
Advantages	This mode facilitates collaboration between current and past students.
	The assessments in the updated course material mode can be used as a review tool for past students by allowing them access to the assessment module in a self-check capacity. Current students would be allowed access to the assessment module on a predefined schedule and would to receive grades for the assessment.
Disadvantages	There is a potential issue when a significant area of a course is updated from one year to the next. The issue is related to supporting past students in the updated content.
	The release of sequenced content (e.g., PBL case, case study, etc., in which engaging with the content for the first time, having information out of sequence interferes with the intended learning opportunities) EDITS OK—THIS WAS CONFUSING becomes an issue in the updated course material mode. Current students would still see sequenced content released on a predefined schedule.
	In allowing past students access to all sequenced content, collaboration would need to be moderated to ensure the integrity of the sequenced content.

Extended Update Mode	Comments
Access	All students have access to all current course materials regardless of when they occur in the curriculum.
Advantages	Fosters self-directed learning and encourages review of previous material.
Disadvantages	Display of any content that is designed for incremental release.
	Increased cost if a commercial proprietary system is used.

In order for students to retain access to all courses across all years, security will require that students be identified by graduating class cohorts. The cohort model would need to be supported as either a role or group in the LMS security model and be supported by the student information system with which integration is common and enrollment is controlled. This support would also include a process to keep the cohorts up-to-date. These cohorts would be used to provide access to the appropriate course or course content regardless of the mode utilized.

Within the LMS, the cohorts would have their access level determined by defined roles. These roles would be used for faculty and staff as well as the cohorts of students. These roles include but are not limited to:

- Active student
- Auditing student
- Past student
- Instructor
- TA
- Administrator(s)

These roles in the cohort security model of the LMS would be used to deliver sequenced content to an active student while allowing all access to a past student. In the same way, current students would have access to the assessment module for graded exams and quizzes while past students would use the assessment module for self evaluation (in some cases, e.g., "high-stake" assessments would be restricted and have additional security features and would not necessarily be available for self-evaluation purposes).

In both the archived and updated course material modes, additional support for dealing with the various cohorts will need to be provided. Support will also be needed for past student cohorts and for dealing with the updated or new content areas. In the archived material mode, support would be needed for updating course material. Within the updated material mode, additional support would need to be identified for:

- Updating course material
- Updating cohort membership
- Moderating activities for collaboration activity modules

The persistence of course material in the archived course material mode is maintained within the archived class. With the update course material mode, the persistence is maintained by updating current course content for all cohorts. For the updated course material mode, persisting content across four years of student cohorts presents potential copyright issues. In the archived course material mode, copyrights are obtained for the number of students in a class cohort. However, in the updated courses material, mode rights for copyrighted material will need to be obtained for the number of students across all four years. Therefore, with either mode, the best practice is to obtain permission to use copyrighted material for the number of students in all four years.

The archived course material mode does not facilitate collaboration between current and past students because of the segregation between the current and archived course content. Also, because this mode is for completed courses, there is most likely very little collaboration among the students with access to these materials.

The updated course material mode facilitates collaboration between current and past students because it allows for peer teaching through moderated discussion boards and chat modules. Through these modules, current students can ask past students questions about course content. The moderated communications between past and current students would help to maintain the integrity of sequenced content. In this mode, past students act as peer tutors/ teachers for current students, while current students can act as peer tutors/ teachers for updated content that would be new to past students.

For ease of maintenance, continuity, and review, the Extended Update Mode is preferred. The Extended Update Mode fosters self-directed learning by presenting all material available and letting the student set the pace of learning. This mode could facilitate collaboration between current and past students because it

allows for peer teaching through moderated discussion and chat tools. By sustaining up-to-date content, students are provided with a valuable tool to maintain and increase their knowledge.

The disadvantage to the Extended Update Mode is the cost associated with supporting such a model. Faculty time, management of intellectual property, and the necessary curricular support staff work time are just a few factors that must be weighed. Learning Management Systems may not allow for this type of content update, storage, or access by all students across all four years.

2. Integrating LMS into a medical education portal.

A portal is "a site serving as a guide or point of entry to the World Wide Web and usually includes a search engine or a collection of links to other sites arranged especially by topic (**definition from Merriam-Webster**)."

Ideally, access for any LMS system under consideration would have the ability to function as part of a portal for accessing and inputting a variety of information by a diverse user population, including students, faculty, and administrators. Such a system should avoid redundancy by sharing faculty and user data among systems, including scheduling, registration, online assessments and grade books, and course calendars. The LMS/portal should also provide enough flexibility to meet the discrete requirements of the various stages of medical education (UME, GME, CME). It should include the ability to view and edit multiple content formats and provide access to discussion threads and online learning tools. The LMS should track clerkship patient encounters, learning objectives across the curriculum, and usage of resources (i.e., most accessed/used resources). Students and faculty should be able to collaborate and/or build learning material. Educational/clinical responsibilities should be listed prominently. A global search function should be available.

The basic course information can be shared with CurrMIT so that this data is available to other schools. To ensure persistence, a standardization of terms and processes for adding metadata should be established.

Collaboration is a key element of any LMS and should include the ability of cohorts to have easy access to various LMS tools requiring a moderator, such as discussion boards and chat rooms. It should allow cohorts to engage in peer teaching and learning. Additional collaborative elements should include file sharing, message boards, teacher-created and instructor-created groups, as well as other content and administrative tools.

As an example, Wake Forest University School of Medicine has integrated the LMS on SharePoint with its Education Portal (eWake), which allows students and faculty to access resources from a single gateway. The tools used to build the portal are Microsoft SQL and .NET framework. Microsoft SharePoint has also been used for many elements of the portal. For example, each clerkship has its own SharePoint site that houses course materials, course objectives, schedules, evaluations, assignments, discussion boards, contacts, etc. SharePoint is also used as a miscellaneous bulletin board for students. Students use this area to hold documents, post pictures, host discussions, and conduct surveys.

The eWake portal at Wake Forest University School of Medicine is used as an entry to all curriculum materials and links that medical students need throughout their education. The central item is the calendar that displays the individual student's educational schedule. Drilling down into this calendar per event allows the student to gain access to course materials uploaded by the teaching faculty or administrative staff.

In addition to this calendar, students can also add links to internal resource sites, such as electronic journals, databases, and textbooks; various electronic teaching applications such as the Human Anatomy Atlas, Hyperbrain, and Virtual Microscopy; financial aid; student services; a student directory; and the Medical Center electronic medical record. There is also a section to hold links to any favorite external URL that the student may use frequently. The portal also has sections where policies, reference materials, and small group cases are accessible. The SharePoint bulletin board is also accessible from the eWake portal.

Teaching faculty use the portal to gain access to all of their teaching materials. They are able to use utilities to upload, delete, and maintain their materials as well as to add course objectives and link them to USMLE standards. All of their teaching activities are listed for their review. The administrative staff use the portal to assign small group facilitators, make announcements to students, assign and release evaluations, and track evaluation completions, among other things.

The portal also has a search function that will search across the curriculum by lecture titles, objectives, and/or files. This search capability has the intelligence to only allow searching of materials for which the student currently has access. For instance, the search by a first-year medical student would not search curriculum in any other year of medical school that has not yet been released to this student.

In summary, we would recommend that the LMS be integrated with the Education Portal to make full use of both technologies. The LMS should include the continuum of medical education (i.e., undergraduate medical education, graduate medical education, and continuing medical education). The basic information in the LMS can be shared externally (i.e., with other schools) via CurrMIT (a free service from the AAMC). This will allow medical schools to collaborate with each other. With proper support and strategy, a LMS can be successfully integrated with the Education Portal at any school.

3. The LMS should support some form of collaboration, preferably technology that supports team projects.

Collaboration is sharing information and knowledge through the act of working jointly with one another. Most often in the learning space, collaboration occurs on group projects as part of a course.

A key element of an LMS is its ability to foster collaboration across platforms, databases, and institutional departments. This means, among other things, common access to databases, electronic bulletin boards, discussion rooms, and other tools. Collaboration across department disciplines and institutional domains enriches the teaching and learning process and contributes to the more complete formation of students in their understanding of materials and practices. Older models of education consistently ran the risk of balkanizing their subject matters and isolating any particular course from the larger field of inquiry and idea exchange. Now that technology can permit immediate sharing of ideas, conversations, and materials via e-mail and other kinds of communication, an LMS must be able to capitalize on the tremendous benefits that such communication offers and actively encourage the LMS users—faculty and staff, as well as students—to invest themselves in the educational process. Collaboration contributes to the inter-institutional goal of producing well-informed individuals accustomed to a variety of learning processes and able to meaningfully contribute to the ongoing process of cooperative teaching and learning.

Collaboration is an essential aspect of the learning process, especially in the context of medical education. It is through collaboration during education that students can learn the skills needed to be a part of a multidisciplinary health care team that is prevalent in modern health care practice. The art and skill of effective collaboration can best be undertaken by experiential learning. As medical education and medical practice incorporates more electronic technology, it follows that the learners should have the opportunity

to learn collaboration in the digital environment as well as by maximizing the availability of the Internet, especially Web 2.0 technologies.

Collaboration tools fall under the following categories:

- **Real-time chat**—whether audio, video, text-based, or combination—allows geographically separated learners to have common experiences.

- **Discussion boards** allow learners to engage in discussion over an extended time period. This contributes to broader perspectives than might have been held otherwise. As with real-time chat, discussion boards allow for geographically separate learners or groups of learners to interact.

- **Shared document/whiteboard capabilities** allow for multiple people to contribute and edit documents. Some applications of this tool also allow for real-time collaboration.

- **Wikis/blogs/podcasting** allow individuals and teams to create, edit, and refine their own content on an ongoing basis and publish it to various formats.

Given that the goal of the LMS is to support learning, and that collaboration is an important component of learning, the LMS should support a variety of collaboration abilities. It is not essential that the collaboration tools be fully integrated with the LMS, but from the perspective of the learner it would provide a more cohesive experience if the tools were integrated. Also, if the collaboration tools are independent from the LMS, it would be more difficult to integrate that content with the broader content contained in the main LMS. From the administrative standpoint, it would be easier to maintain integrated tools than stand-alone ones.

The LMS is an inherently collaborative medium, and as such can be beneficial at the institutional level for those schools that participate in sharing content and other curriculum. The benefits of collaboration tools vary according to how an institution uses the LMS. For those schools that use the LMS as a supplement to physical interaction, many find that discussion on topics continues long after the class ends and leads to deeper engagement with the material. It has also been used as a way to extend discussion to topics that cannot be covered during the limited in-class time. On the other end of the spectrum, where online means are the sole method of delivery, collaboration tools are an essential means of providing similar discussions and projects that happen naturally in the offline world.

The Mayo Medical School has used group wikis as a collaboration tool with its anatomy class. Rather than simply present a group paper at the end of anatomy, each group has built its project on a shared wiki. This type of collaboration has had the benefit of allowing better access to the information even after the class was completed. Another inter-institutional collaboration involves two medical schools in Minnesota that encouraged their respective first-year students to share their institutional and personal experiences with their counterparts at the sister institution. While this project is in its beginning stages, the goal is to better understand the differences between the two schools and look for future ways to enhance education for both institutions.

A third example of collaborative tools in medical education is the use of wikis at Albany Medical College, in Albany, N.Y. In the third-year family medicine clerkship, all students contribute to a family medicine wiki. (Geyer, E., and Irish, D.E. “Isolated to Integrated: An Evolving Medical Informatics Curriculum.” *Medical Reference Services Quarterly* 27 no 4 [Winter 2008]: 451-461). The students are required to post or edit at least one entry during their clerkship, and the wiki is used as a knowledge base for subsequent groups. The wiki is hosted on Sakai, the institution’s learning management system, to ensure that only authorized individuals see the information.

In summary, selection and implementation of the LMS should foster maximum collaboration within and across institutions. It must be an *intrinsic* element in the learning environment such that it allows students and teachers to easily make use of collaboration tools in their learning and teaching activities. It must be adequately supported from the standpoint of both hardware/software infrastructure and faculty training. Such a learning environment ultimately helps prepare medical students to become physicians well prepared for collaboration with other health care professionals in the treatment of their patients.

Infrastructure, Security, and Technical Support

Security issues and technical support for the basic principles of access, portal functionality, and collaboration are closely related and are described collectively. In general, an LMS should support one point of access with a single sign-on to the LMS (to allow users to move between LMS and institutional databases without having to enter multiple usernames/passwords); and have secured user access, including some common and continually updated method of authentication and data encryption. An LMS needs to have plenty of bandwidth and storage capabilities. This system should be maintained according to the standards of campus network security while allowing for intra-campus and external access. Security should be role-based, with access to various components of the LMS being defined by the user role. Interoperability, cross-browser, and cross-platform issues (e.g., Windows Vista—many programs do not work the same in Vista, as well as IE/Firefox/Opera, etc.) need to be considered. And it should have user tracking/trending, accountability, secure files, folders, applications, and databases.

There should be well-defined security policies and processes. The LMS should support some kind of nested security so that users within their own defined permissions can themselves enable additional security and lock particular items. Optimally, security and access would be maintained by a central group, which would be most familiar with the users of the system (e.g., Office of Medical Education).

Technical support should also be provided by a central group in which various experts work together to resolve any issues and continue to build/enhance and maintain the LMS. This requires robust support, beginning with strong communication between the educational and technical units. The educational unit must identify key components required of the system to support the curriculum and administrative objectives of the educational program(s) and work with the technical unit(s) on how best to deploy those components. Administrative support will include user management according to defined roles of courses, instructors, facilities, and report generation. Technical support will be required for system maintenance, upgrades, troubleshooting, etc. Appropriate staff or TAs should be available to moderate discussion boards. One should plan ahead of time for providing support to troubleshoot hardware/software, generate reports, regular data cleanup, and build/maintain utilities the creation of course materials.

This should include user training (including follow-up training if desired) and documentation. Ideally, this central group should be a single system and would have extended hours and pager contact numbers for after-hours emergency service. In terms of support, the number of support staff for the LMS would vary depending on the institution's needs and size. It should also be recognized that there will be a continuum of support needs, from basic "how-to"-type questions to issues of a technical nature that arise from the specific use and environment used. Institutions should take care to ensure that the widest range of support is covered in some fashion to ensure high levels of technology satisfaction. It would support all levels of the LMS and would also include in-person training, online educational materials—such as online tutorials or PDF/PowerPoint documents or a combination of both, and online chat room support. Different systems are more complex or offer more features than others, so training time will vary among institutions. Training should be offered at different times throughout the year, to ensure continuous and maximum audience potential, an up-to-date knowledge base, and troubleshooting skills and techniques.

LMS Review and Selection Process

Following the GIR presentation in April, the LMSG was asked to include a section on best practices for selecting an LMS. The group has included this section as well as a general guide and overview of the LMS selection process for academic IT decision makers.

Selecting a Learning Management System

While each school's specific requirements for a learning management system differ, there are key principles for selecting an appropriate LMS. A collection of experts from different schools developed this six-step framework to serve as a general guide and overview of the LMS selection process for academic IT decision makers. This framework is geared towards identifying a commercial product or vendor with a follow-up discussion about open-source solutions and their unique approach.

Step 1: Consider Audience and Learning Environment.

As curricular needs change and grow, strategies to address teaching and learning challenges change as well. While the focus of education is teaching and learning outcomes, a school's LMS is often tied directly or indirectly to curriculum changes and innovation.

The selection committee should draft a list of key considerations and questions, including:

- Who are the instructors and what are their teaching/delivery styles and needs?
- Who are the learners and what are their needs and expectations?
- In which locations and in what situations does learning take place that will be affected by the LMS?
- What resources are currently used to help achieve successful teaching and learning?

REMEMBER: There are a variety of factors that enable a solution to work in one environment and not in others. Therefore, selecting an LMS solely based on the success it had within another school is ill-advised. Think about the individual school's culture, organizational structure, types and number of programs, and other factors that need to be considered before envisioning a new LMS implementation. This task can be time-consuming, but it is extremely valuable in achieving the desired end result.

Step 2: Determine Requirements.

Requirements should be prioritized from high to low. High-priority (or core) requirements are those absolutely necessary for the LMS to perform during its initial launch. If a core requirement cannot be met by an LMS, that system should be dropped from consideration. Medium-priority requirements must be met in the initial or subsequent phases of implementation. Low-priority requirements are "nice to have" and may be delayed indefinitely.

The following areas of focus are recommended when determining requirements but are not meant to be exhaustive:

Registration and Enrollment: What student information system (SIS) exists and is an interface to the LMS envisioned?

Authoring Tools: What tools are envisioned to develop, maintain, and store learning content? Issues related to authoring-tool compatibility with existing learning objects, version control, and content reuse should be considered.

Content Access: How will learners access content housed in the LMS? What types of content will be delivered?

Collaboration Tools: The functionality of discussion boards, chat rooms, wikis, blogs, polling, and other interactive tools should be well thought-out during this phase of the selection process.

Evaluation Tools: What survey instruments, quizzes, and tests are needed to collect data associated with the effectiveness of programs and the measurement of student performance? Types of available evaluations vary greatly by LMS (multiple choice, matching, write-in, document submission). Systems also vary by offering standards-based import/export and question banking options.

Communications and Workflow: How will students submit assignments and how will instructors collect them? Should a system keep all transactional material internal, or is it acceptable for assignments to leave the system (i.e., use of independent e-mail accounts to send and receive submissions)?

Grading: How are grades calculated, compiled (manual or automated), reviewed, and edited by faculty and shared with students? What formats are grades: letter, letter with plus/minus, numeric, pass/fail, checkmark, text for feedback, etc.?

Languages and Accessibility Accommodations: The LMS selected may need to be customizable in order to meet language needs and Section 503 considerations.

Customizability: Will the out-of-the-box LMS suffice or will the school's needs potentially grow or change over time? Some LMS systems allow add-ons or tailored modules to add different functionality. Other LMS options allow for developing easy tie-ins or even embedded tools.

Technical Aspects: Will the LMS function as a stand-alone system or does it need to coexist with other systems? Single sign-on capability (through LDAP, Active Directory, or other directory services) and portal functionality (such as u-Portal or through an existing portal wrapper) should be considered.

Step 3: Develop a Request for Proposal (RFP).

With a requirements document in hand, a request for proposal (RFP) can be developed. An RFP is used to solicit proposals from potential vendors which should include a project plan for implementing the vendor's solution based on your requirements and financial considerations and constraints. The project plan should include start and completion dates, list the milestones, and identify task ownership for achieving each.

You may wish to consult the EduTools website, a community-driven project sponsored by the Western Cooperative for Educational Telecommunications (WCET), for broad LMS product and vendor information useful in identifying appropriate RFP recipients. The University of Michigan's *Learning Information System Request for Information* is an example of a detailed request for proposal. http://sitemaker.umich.edu/enablingtech/files/20070227lms_rfi_medschool.pdf

REMEMBER: It is not necessary to note the priority weights of each requirement, nor is it important to list them in any specific order. But, be certain that every requirement is specifically worded so that vendors provide details rather than general responses. It is also helpful to provide "scenarios" in the RFP that describe situations in which the LMS will operate. This will assist vendors in giving a context to their responses.

Step 4: Conduct Vendor Presentations and Review Systems.

After submitted proposals are reviewed, meetings and demos should be scheduled so vendors can address specific questions and demonstrate their proposed solutions. If scenarios were provided in the RFP, vendors should be required to demonstrate them. It is also important for vendors to clarify what part of the functionality is included out-of-box and customizations are beyond the quoted price.

REMEMBER: The goal of the review should be to determine if the LMS meets the highest-priority requirements. If a core requirements cannot be met by the LMS, that LMS should be eliminated. For this reason, only core requirements that truly represent imperative functionality should be incorporated. Analysis of the committee's ratings should lead to a short list of vendors. During your systems reviews, consult with peer institutions and organizations such as AAMC's Group in Information Resources for recommendations and feedback. Many groups and universities have been through this process and have published or are willing to share comparison charts and reviews of each system. The references at the end of this document are a good starting point.

Step 5: Research Companies.

Research vendors whose products are in consideration. Although company information is usually available on each vendor's Web site, nonbiased information should be sought. One e-learning firm, Brandon Hall Research, offers extensive resources on LMS products and vendors.

Consider the following when determining the company or provider which whom you plan to partner:

- **Financial Stability:** When possible, evaluate a company's financial status to ensure that it will remain a viable player in the market before making your final selection.
- **Client Relations:** Talking with references can be critical in understanding how responsive a vendor actually is. Prepare a questionnaire to evaluate critical areas that strike your organization's comfort zone.
- **End-User Support:** Ask vendors for their service level agreement (SLA) and pay particular attention to the defined roles, responsibilities and response times associated with various types of incidents. Will the school provide the first tier of support to students or faculty, relying on the LMS vendor as support only to the local support people? Or do all students and faculty members need access to the LMS end-user support team?
- **Pricing:** When considering pricing, reflect on your functional and technical specifications. What would be the cost if the selected vendor didn't conform to the committee's expectations?

Step 6: Make the Selection.

From the committee's careful reviewing and discussions, an LMS can be selected. This is a serious and long-term investment, so it is important to have complete cooperation among the members of committee. It is also advisable to consider a contingency plan in case unexpected delays or problems arise.

Open Source Solutions and Operating Options

Commercial learning management systems such as WebCT, Blackboard, and ANGEL are well known to educators. But, the rising cost of proprietary LMSs has spawned a new market for open-source alternatives such as Sakai (http://www.sakaiproject.org) and Moodle (http://www.moodle.org). Institutions wishing to save money or to have more control of the overall system find open-source learning management systems to have great appeal. Feature-by-feature comparisons among commercial and open-source LMS products often show a high degree of comparability.

Open-source/community-source software is usually free to install, but comes at the expense of higher support since no business is in charge of the system. In general, the costs associated with implementing open-source/community source software are generated through the technical and personnel resources that a school must put towards customizing, implementing, and supporting the solution.

Do It Yourself (DIY)
Open-source LMSs are available in one of two ways. The most common is the do-it-yourself installation in which the school patches the system, installs the application, performs upgrades, and monitors its performance. Interfacing the LMS with the school's student information system and determining a user authentication model consistent with the schools security policies and IT system is necessary. The decision to be entirely responsible for the installation, operation, and maintenance of an LMS requires technically competent staff who will be dedicated to the project.

Vendor Supported Solution
Moodle and Sakai, the two most popular open-source LMSs, are also available as vendor-supported services. For an annual fee based on the number of active accounts in the system, a school can offload the installation, operation, and maintenance of the entire learning management system to an application service provider. Services also include licensing (if applicable), integrating student information systems, customizing the system, and providing technical support to key personnel at the school. Technical support does not usually cover direct student and instructor support. In situations where a school does not have the technology infrastructure or staff necessary to support an always-on system, the service model is appealing and cost-effective. The downside to the service model is that system customizations and overall control can become difficult.

Summary

While every school's requirements for a learning management system differ, most schools follow a similar process for selecting a LMS. The process outlined above has proven successful for the collaborating authors and offers a good starting point for other universities and a way to keep an objective eye based on overall goals. A committee's careful analysis of the learning environment and requirements, a clear RFP, and solid research into systems and vendors should yield a successful implementation.

Conclusions

With the widespread use of LMSs, institutions need to continually examine the potential of these systems for more innovative and collaborative uses. Top considerations for any future LMS include such technological issues as security, support, and availability of the product (i.e., limited downtime). Ideally, it should be able to support the next generation of e-learning tools and be intuitive, customizable, interactive, easy to use, integrable, fast, efficient, and mobile. LMSs should be learner-centric as opposed to course-centric and should support self-regulated learning that is outcomes-based and competency-based instead of time-based. Web-based materials represent another component, and those materials should conform to e-learning standards.

As considerable innovations continue in LMS implementation, it is advantageous for institutions to come together nationally to define and expand best practices to guide universities in implementing future LMS features. To devise an ideal LMS, current systems should be thoroughly assessed for their relative strengths and weaknesses, and further research should be done on the varying potentials of commercial, custom and open-source LMSs. Current systems and system types (open-source, commercial, etc.) should be scrutinized for content and comparatively evaluated to determine whether there is a clear front-runner in terms of service. Not all commercial packages can handle each organization's needs, so the system should be *easily* customizable and integrable with other educational systems.

In addition to best practices, cooperating institutions should agree on common technical, legal, quality assurance, and interoperability standards. Technology standards and specifications for health care education should allow for the exchange of learning components (e.g., online content and training modules, quizzes), data (for aggregate analysis), and software components. Example standards could include IMS (e.g., Learning Design and Content Package), and IEEE (Learning Objects Metadata, MeSH or SCORM for metadata). As features for LMS packages evolve, institutions should also ensure that the standards of interchange evolve to keep pace with new technologies. A focus on standards of interchange, coordination, interaction and interoperability will allow for enhanced inter-school collaboration while allowing for LMS implementation independence between collaborating schools as seamless as possible.

A key point of discussion is the notion of finding one system that has all desired features (institutions can use or not use individual features as preference dictates) or having a system that is built in a modular fashion (institutions can built their own modules with preferred features from the common stock). As mentioned in the document, there is not one system that currently includes all of the desired features, especially with regards to collaboration. Institutions will need to have flexibility to choose individual tools based on their needs. It may be worthwhile to approach the problem from the perspective of being able to connect these different tools in a way that allows for constant change and adaptation while still maintaining a cohesive user experience. By taking the approach of having a Web-based system, it becomes possible to use API architecture in these tools to make use of their capabilities without sacrificing the user experience.

Another important consideration involves the financial and manpower resources to support this initiative. Will there be a specific budget, and who will create it? Staffing issues, particularly related to technical support, remain a concern as well. Other challenges exist including cost and reliability. The value of continuing this discussion and working on common standards and guidelines for LMS that meets the current and future needs of institutions is of utmost value to students and faculty alike.

This paper's intent was to describe this diverse group's discussion and thoughts on this important subject. The next step is to begin planning and implementing these suggestions on a national level with the involvement of the GIR and other key medical organizations interested in further defining, expanding, and overseeing implementation of these recommendations.

Resources and References

Brandon Hall's LMS KnowledgeBase 2008
(http://www.brandon-hall.com/publications/lmskb/lmskb.shtml)
A source of detailed LMS information is the LMS KnowledgeBase 2008, an online service of Brandon Hall Research, an independent e-learning consulting firm. The comprehensive database stores in-depth profiles on over 70 learning management systems and provides detailed company profiles.

EduTools *(http://www.edutools.info/static.jsp?pj=4&page=HOME)*
The EduTools Web site, a community-driven project of the WCET–Western Cooperative for Educational Telecommunications—was built to assist higher education institutions in their decision-making process in evaluating and selecting learning management systems. The Web site reviews each product by researching and describing more than 40 product features and allows visitors to perform product comparisons, search and list features, and use a "summative decision tool" in making a selection decision.

Learning Information System Request for Information
http://sitemaker.umich.edu/enablingtech/files/20070227lms_rfi_medschool.pdf
The University of Michigan's *Learning Information System Request for Information* is an example of a detailed request for proposal specific to a medical school's needs.

California State University-Chico, Learning Management Systems II Strategic Review
http://www.csuchico.edu/tlp/LMS2/LMS%20II%20All_Questions.pdf
CSU Chico's document provides a highly detailed and structured list of questions that can be useful in considering the functional requirements of a LMS.

Top 10 LMS Purchasing Mistakes (and How to Avoid Them) *by Dave Egan, THINQ Learning Solutions*
http://www.coxec.com/Top_10_LMS_Mistakes.htm
Though a bit dated and leaning toward corporate adopters of LMSs, Egan's article raises critical issues important for any LMS purchaser to consider.