

Are Two Course Management Systems Better Than One?

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Abstract - Can an institution with a large student enrollment and a broad array of disciplines satisfy the disparate needs of students, faculty and administrators with a single Course Management System (CMS)? Under what conditions are two CMSs functionally better than one? For over a decade, Michigan State University (MSU) has supported on-line learning with a mix of systems, split between proprietary systems that facilitate discussion-based, collaborative learning and open source systems, offering individualized assessments to facilitate quantitative problem-based learning. In the 2005-06 academic year a commercial system was used by 65,000 students for tasks ranging from accessing class announcements and readings to contributing to message boards. During the same period, the open-source LON-CAPA system was used for 18,000 students, principally for its capabilities in the creation and delivery of individualized homework problems and examinations, mostly in science and math classes, including prerequisites for engineering majors. Although there is typically large overlap in functionalities offered by CMSs, there can also be large differences, thus making a combination desirable.

Index Terms – case study, costs/benefits, Course Management System, LON-CAPA.

INTRODUCTION

Course Management systems (CMSs) have become an integral part of the IT infrastructure used for teaching and learning in many universities and colleges in the US [1]. Although there is considerable overlap in the capabilities provided by these systems, there can be considerable differences in functionality, ease of use, extensibility and scalability.

The preference for one particular system as opposed to another, for use as an instructional tool in a specific course, may often be determined by the available functionality. As a result, in a university with diverse course programs and faculty, more than one course management system may be required to meet the needs of students and faculty. The decision about whether to standardize on a single comprehensive, scalable system, or whether to support multiple systems will be based on an assessment of the institutional costs and benefits of the two approaches.

Costs of hardware (including redundancy and regular replacement/upgrade costs), system administration, software licensing and support, user support for faculty and students, and training for faculty all contribute to the cost side of the equation. Benefits include improved efficiency for both faculty and students in managing their course loads, and a perception of improved student learning (a debatable question, according to the 'No Significant Difference Phenomenon', [2], although our own experience has shown such improvement for some students [3]-[4]). As there is scope for economies of scale, the balance between costs and benefits will vary depending on the extent of utilization of a particular course management system. In addition, as the available functionality can change from year to year as a consequence of ongoing product development and the release of updated versions of course management system software, the balance between costs and benefits is likely to change from one year to the next. The scenario in which a multiple CMS approach is most likely to be preferred to a single CMS approach is one in which different systems have distinctive strengths which appeal to identifiable constituencies. This type of distinctive character is most likely to occur where one or more of the different systems was originally developed to address either the specific needs of certain types of instructional setting (e.g., survey courses with large enrollments and high student to instructor ratios intended for non-majors satisfying a general education requirement), or alternatively the needs of a single discipline or group of disciplines. A distinctive character may not only be manifest in the types of functionality a system provides, but also in an underlying philosophy – e.g., open source versus proprietary, support for customization and flexibility versus uniformity and standardization. The way in which a course management system is deployed in the support of teaching and learning can be a product of the specific character and philosophy of the system. As a result, different systems are likely to appeal to a greater or lesser extent to different constituencies amongst the faculty.

One consideration that is more significant in a multiple CMS approach than in the single CMS case is system interoperability. There is a continuum from tight integration to very loose integration. At one end of the spectrum, tight integration of the systems will include shared read/write

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access to student performance data gathered by the various systems, entry to multiple systems via a common portal (including single sign on), aggregation of a user's calendar and communications data across systems, support for deep linking to content in one system from another system, or alternatively integration of multiple systems with an institutional content management system. At the opposite end of the spectrum, minimal integration might be restricted to employing a common username scheme and authentication method for the different systems, and synchronization of institutional data feeds for administrative information (e.g., class rosters of registered students and instructor(s) of record) required by the various systems. In the absence of an institutional content management system that can support multiple CMSs, there is the practical question of the availability of standards-based utilities for the transfer of course content (or entire courses) directly between the systems. Adoption of a single system however, does not eliminate the need for a CMS to have the capability to import or export courses based on established content packaging standards, because of the movement of faculty through their careers between institutions which have standardized on a single system, but which have adopted different systems.

MULTIPLE CMS APPROACH AT MICHIGAN STATE UNIVERSITY

At Michigan State University, a multiple CMS approach has been used to support online and blended courses for the past few years. The identities of the course management systems adopted for this purpose have changed during this time, as have both the functionality and utilization rates of the different systems (Fig. 1). From 2000 to 2004, a proprietary system (Blackboard CourseInfo 4) was used as the primary general course management system for campus-based courses, while a separate proprietary system (VU widgets) developed by MSU's Virtual University group was used for fully on-line courses and for a small number of residential courses. In addition, the open source LON-CAPA (Learning Online Network with Computer Assisted Personalized Approach) content management and course management system (primarily developed in the Laboratory for Instructional Technology in the MSU College of Natural Science) was used for online courses, blended courses and online homework, principally for courses in the natural sciences. Since 2004, the proprietary ANGEL system has replaced CourseInfo 4 and the VU widgets, and there has been an expansion in the use of the LON-CAPA system to include courses in the Colleges of Engineering, Education and Business.

Aside from an individual instructor's preference for a particular user interface, and/or a familiarity with a specific course management system through prior use, the strongest argument for continuing support of multiple systems is the widespread utilization of features unique to a specific system. Equally, if an institution is currently operating a single CMS, the strongest argument for moving to operation of multiple systems would be identification of teaching and learning objectives not well supported by the current system.

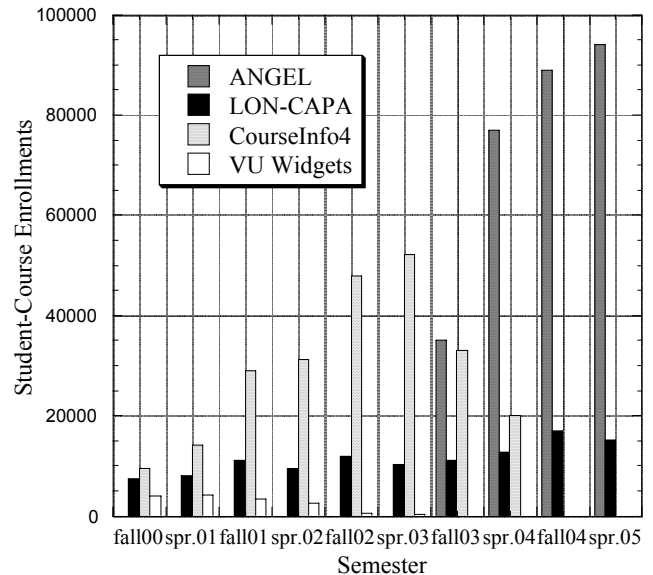


FIGURE 1

MSU STUDENT-COURSE ENROLLMENTS IN VARIOUS CMSs 2000 - 2005.

CHARACTERISTICS OF THE LON-CAPA SYSTEM

The LON-CAPA system is distinct in several ways from both the CourseInfo 4 and ANGEL systems with which it has coexisted. From the outset LON-CAPA was designed to function as both a course management and content management system. Furthermore, content management is cross-institutional, permitting sharing and re-use of learning objects between courses within institutions and also amongst the different institutions which have adopted the system and have requested that their domains become a part of the LON-CAPA network. Cross-institutional content sharing lends itself particularly well to the teaching of introductory courses with large enrollments in science and math which have a well established curriculum.

LON-CAPA is based on two predecessor systems, one of which is CAPA (Computer Assisted Personalized Approach), [5]. As a consequence of this heritage, the LON-CAPA system is very strong in the area of personalized assessment, and further, because its earliest use was in the natural sciences, it has comprehensive support for the display of mathematical typesetting throughout the system, and also problem-based learning which involves finding solutions in which the answers are numerical (with appropriate units), an algebraic formula, or conceptual (e.g., up, down, greater than, less than etc.). Support for the generation of dynamic 2-D plots of curves or data sets, personalized to each student is also provided through the use of embedded GNUplot [6] functionality. Similar support exists for the generation of 2-D bit-mapped images through the use of the embedded perl GD module which interfaces to the GD graphics library.

A fundamental philosophical difference exists between LON-CAPA and other course management systems

concerning the approach to the creation and delivery of assessments. Although the LON-CAPA provides templates for the creation of the types of assessment items course management systems commonly make available for use in online courses (e.g., multiple choice, true/false, fill-in-the-blank, essay questions etc.), instructors building assessments in LON-CAPA also have access to a highly sophisticated assessment engine which permits them to craft multi-faceted composite questions using an XML-based approach. Complex assessments may be assembled in a flexible way by combining different XML tags which describe different problem elements and utilizing inbuilt scripting capabilities (scripted in perl) to create assessments that are personalized to the individual student, and potentially to the individual's current course state.

XML description used in LON-CAPA assessment items

- **Script Blocks:** perl scripting support for scalar, array and hash variables, subroutines, and access to LON-CAPA provided functions (including randomization, math functions etc.)
- **Parts:** individual assessments may consist of multiple parts.
- **Random Lists:** display of N of M available items.
- **Blocks:** blocks which are conditionally displayed to the student.
- **Randomly labeled images:** Letters are used to label particular features in an image; different students will see different permutations in the arrangement of the letters.
- **HTML mark-up:** including embedded multimedia objects.
- **TeX typesetting:** Incorporation of TeX used to formulate mathematical expressions and equations rendered appropriately for web pages or PDF pages for printing.
- **Adaptive Hints:** display of different hints triggered by specific student responses to an assessment question.
- **Dynamic plots:** 2-D plots of dynamically generated data or standard math functions generated by GNUplot .

Another difference in the design of LON-CAPA which sets it apart from CourseInfo 4 is the philosophy underlying organization of content in a course. Although course content can be presented in LON-CAPA in a hierarchical arrangement of nested folders containing web pages, assessment items and other media, which a user can visit according to his/her own individually determined access pattern, a course can also be configured to require students to follow instructor-defined paths through the course material. These paths may be adaptive, based on student progress, and may also be configured to vary for different students or groups of students. ANGEL also provides the ability to control access using triggers which can incorporate a user's state information (e.g., class standing).

Irrespective of whether an instructor chooses to define prescribed paths through the course content, the access control capabilities available within LON-CAPA provide great flexibility when teaching a course with multiple sections. Student enrollment from the sections can be merged, but the

section affiliation of the students can be retained internally, and used to map to membership of a particular section and/or one or more groups. Content available to the different sections or groups can then be customized, as can the opening and closing dates for access to the materials.

The ability to control access to course content based on section affiliation is just one aspect of an additional defining difference in the LON-CAPA system compared with the other systems used at Michigan State University. This difference concerns the ability to set parameters that determine when and how content will be made available to each student (e.g., open between specific dates/times, subject to a time interval once accessed, or only available to users from specific IP addresses, or only available to specific sections or groups or individuals) and the style of rendering and type of interaction with the content item that is available to each student. Styles of rendering for assessment items include rendering as a web page for online homework or an online exam, as well as rendering in a compact PDF format suitable for printing (e.g., for self-study or for a paper-based exam). The type of interaction available can encompass access to a discussion board attached to the content item, in addition to the numbers of tries available to each student to answer an assessment item correctly. LON-CAPA employs a cascading scheme for parameter precedence to determine which setting applies to a particular student's access and view of a content item in a course. Under this scheme, a parameter set for an individual student supersedes a group setting, which in turn supersedes a section setting, and a course setting. Similarly, a parameter setting for an individual course item supersedes a setting for the folder which contains the item, which in turn supersedes any default course setting.

Multiple representations of course content not only permit a particular item to be used in different ways (e.g., in a homework problem, in an online quiz, and in a paper-based examination - with each student's answers bubbled onto a scantron sheet - (with automatic grading in all cases), but also in multiple instances in the same course. The randomization provided by the LON-CAPA problem rendering engine can result in a problem with different numbers, options, image labels, dynamically generated plot(s), and different images being presented to a single student in different folders in the course. The random seed which governs the randomization of dynamic elements in an assessment item depends on the username of the user viewing the item, and also an ID number and the internal name of the folder which contains the item, which taken together will be unique to each instance of the assessment item.

COMPARISON OF COURSEINFO 4 AND LON-CAPA USE

To understand how different course management systems have been used at Michigan State University, usage data were compared for the 1039 courses which used the Blackboard CourseInfo 4 system during spring semester 2003, and for the 61 courses which used the LON-CAPA system during fall semester 2005. These two semesters were chosen for the respective systems, because in each case the snapshot of

system use occurred several semesters after the corresponding system had first become available at MSU, so the cohort of faculty users included both experienced users (the original, early adopters) as well as less experienced users. As it is likely that recommendations from departmental colleagues will have played a role in influencing an individual instructor's decision to adopt one of the two systems, some commonalities in the manner of use of a particular system might be anticipated. This is especially true for the LON-CAPA system because of the immediate availability to new adopters of well-tested learning objects in certain disciplines (e.g., physics, chemistry, biology) from the cross-institutional repository.

Courses which employed the Blackboard CourseInfo 4 CMS in spring 2003 spanned a range from graduate classes with small enrollments to large enrollment, introductory level, undergraduate classes (Fig. 2). Usage of LON-CAPA was much more heavily weighted toward 100 and 200 level courses with large enrollments (Fig. 3).

Adopters of the LON-CAPA system typically made use of the system in ways which demanded significant student engagement, as measured by the number of content items incorporated in most LON-CAPA courses, and the relative importance of assessment items (either as homework problems or as exam items). Delivery of online homework was an essentially universal activity in LON-CAPA, whereas use of the system to generate exams was more selective (Fig. 4).

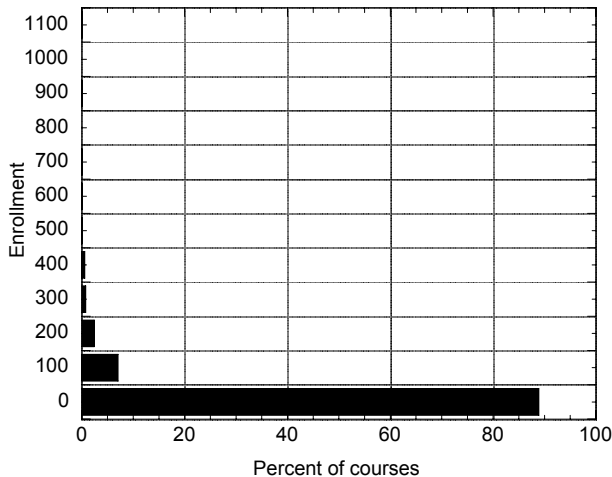


FIGURE 2
STUDENT ENROLLMENTS IN MSU COURSEINFO COURSES, SPRING 2003

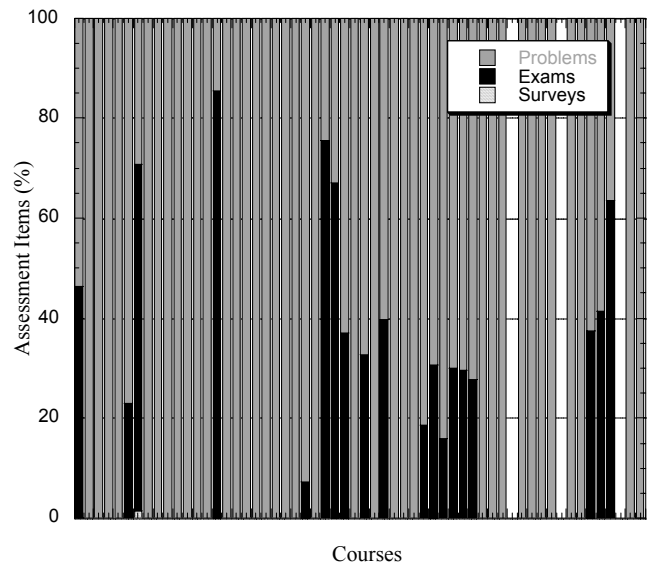


FIGURE 4
PROPORTIONS OF HOMEWORK PROBLEMS, EXAM QUESTIONS AND SURVEY ITEMS IN 61 MSU LON-CAPA COURSES IN FALL 2005

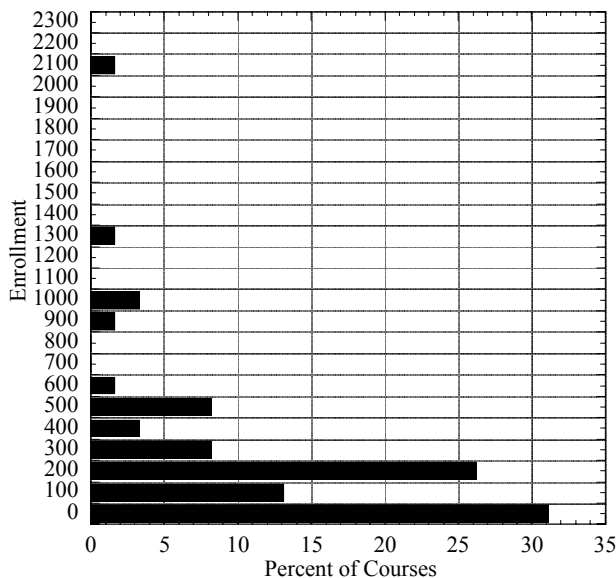


FIGURE 3
STUDENT ENROLLMENTS IN MSU LON-CAPA COURSES, FALL 2005.

CourseInfo 4 use displayed less uniformity, and the quizzing capabilities of CourseInfo 4 were not widely used. In some courses, reading and responding to bulletin board postings was strongly emphasized (Fig. 5); whereas in other courses, upload of files by students to the digital drop box was an important activity, while in other cases posting of grades to an online grade book was a key component of course use. However, in all facets of available CourseInfo 4 functionality, the number of courses in which a particular feature was *not* employed far outweighed those in which the feature was actively and widely used. The differences in the relative uniformity of feature use between LON-CAPA and CourseInfo 4 may owe much to the large difference in the numbers of courses using the two systems. If the same analysis were restricted to the sixty courses making the most extensive use of the CourseInfo 4 feature set, the pattern of use might more closely resemble that displayed in LON-CAPA courses.

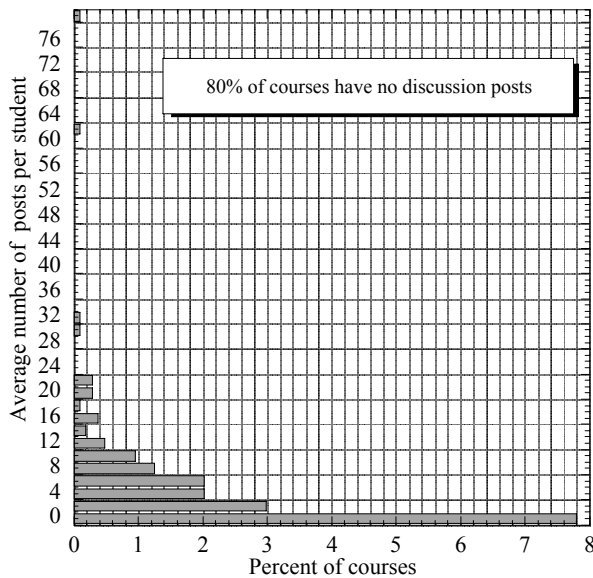


FIGURE 5
DISCUSSION POST ACTIVITY (AV. POSTS), MSU COURSEINFO, SPRING 2003

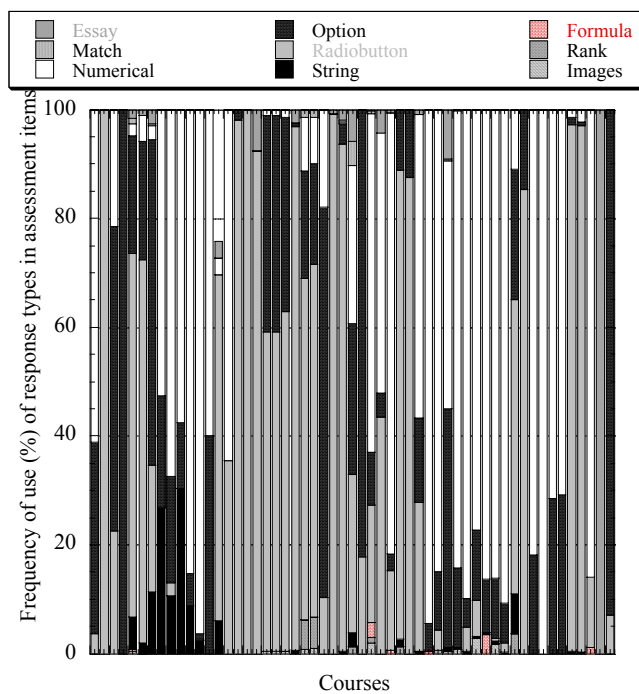


FIGURE 6
DIFFERENT RESPONSE TYPES USED IN MSU FALL 2005 LON-CAPA COURSES

Analysis of the Fall 2005 LON-CAPA courses shows that all of the different response types are in use (Fig. 6), although the relative importance varies between courses – some instructors favoring numerical response type problems, whereas others employ option response questions (in which one option has to be selected from a list of possible options), often aggregated in concept groups. Based on the count of multiple occurrences of a single problem in a particular

course, it is evident that several instructors have chosen to exercise the capabilities of LON-CAPA for multiple representation of a single resource, initially as an online homework item, then subsequently as an exam item, and additionally as an item in a “corrections” exam. This style of presentation provides students with an opportunity to revisit exam material following an exam, by affording them the opportunity to complete new online versions of the same problems which they had previously seen in the paper-based exam, scored by scantron and graded by LON-CAPA. As an incentive for the student there is a possibility of boosting the original exam score by one or two points as a result of a strong performance on the corrections questions.

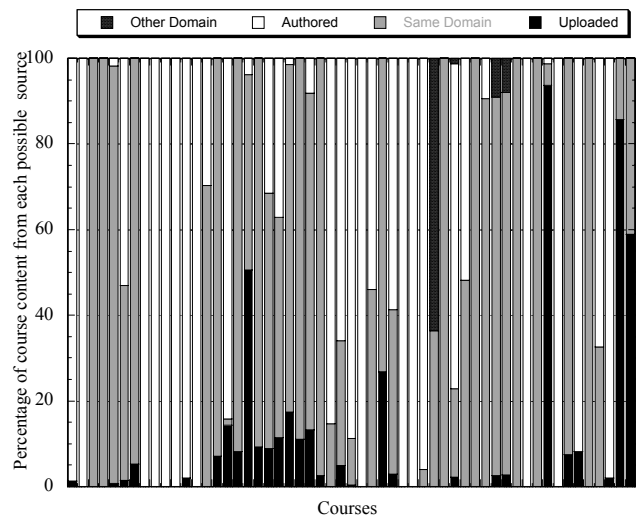


FIGURE 7
SOURCES OF COURSE CONTENT : MSU FALL 2005 LON-CAPA COURSES

The availability of several methods for importing content into a LON-CAPA course is manifest in the varied origins of course materials that contribute to the 61 LON-CAPA courses which operated in fall semester 2005. Materials include items uploaded directly into a course, as well as item authored by the course instructor, but first published to the LON-CAPA content repository prior to import into the course, items created (and published to the repository) by other MSU faculty, and published items imported from domains outside MSU. All four categories of content are represented amongst the fall 2005 course materials, although materials imported from the repository, and either originally published by the course instructor or an MSU colleague are the most prevalent (Fig. 7).

LON-CAPA USE OUTSIDE MICHIGAN STATE UNIVERSITY

Currently 39 universities, colleges and community colleges have access to learning objects in the shared content repository through participation in the LON-CAPA network. As shown in Fig. 8, half of these institutions have reported the enrollments in LON-CAPA courses. Although MSU presently has by far the largest total student enrollments in LON-CAPA

courses, as well as the largest number of courses, LON-CAPA also performs an important role at a number of other institutions. Similar usage data to that gathered at MSU have been acquired for a subset of these institutions. All three institutions surveyed provide faculty, staff and students with access to a proprietary CMS, in addition to operating the open source LON-CAPA system: WebCT Vista at University of Illinois Urbana-Champaign (UIUC), WebCT CE at Simon Fraser University (SFU), and Blackboard at Florida State University (FSU).

with each homework problem. All response types are represented in LON-CAPA courses at the three institutions outside MSU, with multi-choice, option response, numerical and string matching being the most important. Several SFU and FSU courses incorporate content items created by authors at domains outside each home institution, and published in the shared repository. By contrast, courses at UIUC incorporated only items created by the instructor or a local colleague.

CONCLUSIONS

The availability of more than one course management system at Michigan State University successfully addresses the diverse needs of faculty who teach different disciplines, for which there exist particular specific instructional technology requirements that are not necessarily met by a single system. Faculty (predominantly in the sciences) who use the LON-CAPA system take advantage of the inbuilt content management and assessment capabilities to incorporate learning objects created by their colleagues, into their own courses, as well as creating and sharing their own materials. Proprietary course management systems licensed by MSU (currently ANGEL, and previously Blackboard CourseInfo 4) appeal to different constituencies amongst the faculty, and have been employed as a means of making course notes available to students, and promoting communication between student and instructor, and between students. The discrete constituencies of faculty users, underlying system philosophies and feature sets of LON-CAPA and ANGEL are sufficiently distinct that the benefits of adopting a dual CMS strategy at Michigan State University more than compensate for the added cost of two systems. Data gathered for three other institutions in the LON-CAPA network also show the value of LON-CAPA deployment in a dual CMS environment.

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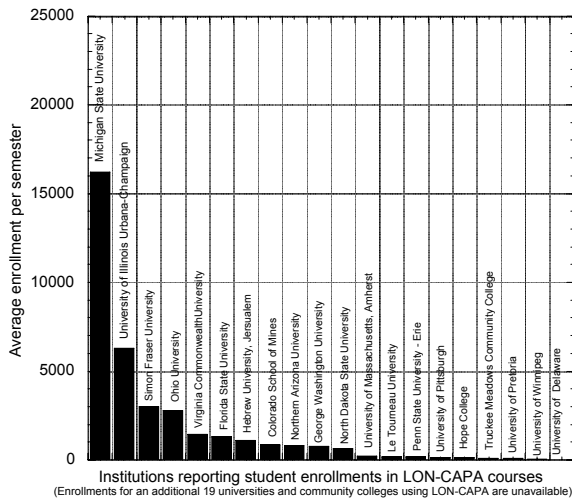


FIGURE 8

AVERAGE STUDENT ENROLLMENTS IN LON-CAPA COURSES BY INSTITUTION

The dominance of large enrollment classes (as at MSU) is less pronounced for these institutions, with Simon Fraser University, in particular, employing LON-CAPA in several classes with enrollments under 200 students. The division of assessment items between homework problems, exam problems and survey questions is more weighted toward homework problems at these institutions than is the case at MSU.

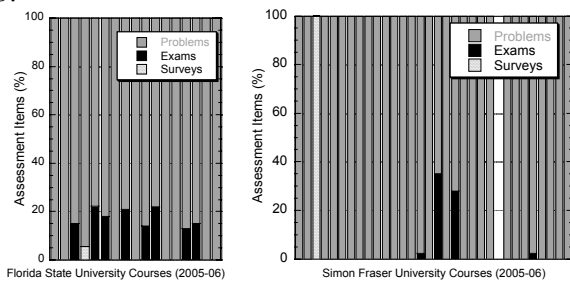


FIGURE 9

PROPORTIONS OF ASSESSMENT ITEMS IN FSU AND SFU LON-CAPA COURSES

As is the case at MSU, adopters of LON-CAPA at UIUC, SFU and FSU use the system in ways that encourage student engagement. Evidence for this comes from (a) course item counts which commonly in excess of a hundred items, (b) the ubiquity of assessment items, and (c) the frequency of student contributions to contextualized discussion boards associated