Development of a Web-based Course Management System for Undergraduate Laboratory Courses

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Introduction

Undergraduate Civil Engineering (CE) lab courses provide students with valuable hands-on experience to reinforce what they learn in lecture courses. In the lab they see how the information illustrated in their text books or instructors' presentations can be realized in "real world" situations. These lab courses also assist students to interrelate various concepts they learned from a variety of classes (math, chemistry, physics, engineering materials, fluid mechanics, etc.) In each lab course, students work in small groups with various measuring instruments for collecting data by following standard procedures. The data collected must then be organized and shared by the members in each group in order to prepare their individual or group written or oral reports. In addition to the collected data, other information, such as principles and purposes for each experiment, operational steps, report requirements, etc. needs to be disseminated to students in advance so that students can avoid a "black-box" effect which would hinder their learning process. A course management system needs to be developed to manage the information described above.

A practical course management system has to be a system that would allow students to easily use the system and also provide a simple process for the course instructor to routinely maintain it. The navigation procedure that all users would follow should be simple and straight forward. The operation of the system should be independent of various computer systems but still be able to exchange relevant data with other systems as needed. A web-based course management system (WCMS) to augment (or assist) traditional laboratory courses is an effective tool to be used in this environment. This paper describes the development of the WCMS of the CE Department at Southern Illinois University Edwardsville. This system can be accessed as needed by students, graduate assistants and instructors at any time by using any computer with a web connection. The system not only displays necessary course information but also allows students to input and correct their collected lab data.

Deficiencies encountered in commercially available WCMS

The CE department at Southern Illinois University Edwardsville (SIUE) decided in the late-1990s to investigate using the web to augment our laboratory courses. Over the past ten years, the department has monitored the commercially available course management software packages, first WebCT and subsequently Blackboard, used at SIUE and concluded that they did not adequately address the needs of our students in undergraduate laboratory courses. One of the chief concerns was that commercial course management systems at that time were mostly designed to provide information from the instructor to the student. Although some means were typically provided to allow students to upload files or send feedback to the instructor, the

capability was limited and inflexible. Moreover, the commercially available systems did not easily support, if at all, the exchange of data with other systems such as the data acquisition systems used in our CE soils and materials laboratories. Another concern was that we would not be able to easily add desired features or modify existing ones in a system developed for a broad market. We were concerned about timely resolution of problems that occur, which our IT department has had to deal with for some time now (Rossow 2008) and this could present significant problems for students relying on the system for their course work. And finally we, as well as many others in similar positions, are not comfortable with adopting proprietary commercial solutions since we would be locked in to limited options and other potential problems mentioned above (Campus Technology 2007). Even as commercial course management systems evolved, these issues have not been resolved to our satisfaction.

SIUE CE WCMS system description

Background

We began developing our own WCMS in fall 1998 to support the special needs of our undergraduate laboratory and related lecture courses. Over the following ten years the system has gone through several revisions with many new features and refinements added. Most of the work has been done by the lead author as well as a number of undergraduate and graduate student workers. As the result of these revisions and refinements, the system now provides many useful and beneficial functions and features for our students and teaching staff.

SIUE CE WCMS architecture

The WCMS is a web-based system built around Microsoft Access databases. Users interact with the data using web pages that include dynamic data provided by ASP server-side scripts that connect to the WCMS databases. Figure 1 illustrates the overall architecture of the WCMS system. All CE website visitors have access to the course syllabus and general information related to the course. A major portion of the system though contains information and applications that have controlled (restricted) access. This is discussed in greater detail below.

Special functions and features in the SIUE CE WCMS

In general, the SIUE CE WCMS consists of three major functions: (a) online access to the course syllabus and other information for the course and a helpdesk for lab test procedures; (b) data input section for manual data input as well as for data collected from an automatic data acquisition system; and (c) evaluation section for quizzes or for group members' evaluations used for grading student's group reports. User access to the first function is open to all who visit the course web site. However, the rights needed to access the other two functions are controlled and restricted to teaching staff and students currently enrolled in the courses. The student course enrollment login function of the system uses the University's validation of the student login ensuring that only currently enrolled students can log into the system for each of the restricted areas of the courses. For more precise control students can be assigned to one of several lab groups and the system permits the student to post data only to his/her assigned group dataset(s).

In the system, a number of features that we have found useful but as a group may not be available in commercial CMS software packages, include:

- experiment data entry and retrieval

- assignment and exam schedules and solutions
- group member evaluation
- interactive lab assistant
- quizzes
- access to course-related reference materials
- instructor tools

These features will be described in detail in subsequent sections.

Experiment data entry and retrieval

Two general methods are provided for lab experiment data input purposes. The first method consists of a number of online forms that the group leader of a lab experiment uses to type in information manually collected during the experiment. This is particularly useful because it helps the group members maintain an organized repository of the collected data. It also helps to share data in the group that is collected outside of the initial lab period for experiments with multiple subsequent tasks and measurements. A second database was established to store data automatically from data acquisition systems used for some of the lab experiments. This data is uploaded directly by our GENTEST data acquisition system - students do not have direct access to this database other than to view data collected by the automated system. Once data is entered to the system all of the students in the course, as well as the instructor and teaching assistant can view it. Students and instructors can also see which students lead particular labs.

Assignment and exam schedules and solutions

Instead of handouts provided to the students at the beginning of the semester, assignment and exam schedules are made available on the course website. Following collection of each assignment or exam the instructor can elect to make the solution available to the students. This system not only reduces some paper but also allows changes to be easily made to the dates or solutions files.

Group member evaluation

The Accreditation Board for Engineering and Technology (ABET) requires each CE student to have teamwork experience (Teamwork Assessment). The group lab report is a way to demonstrate that students have had this experience and how they have benefitted from it. Grading of group reports consists of an assessment of the grade awarded to the report and each individual member's contribution to the report. To better evaluate the individual contribution an online group member evaluation is used. In this application students evaluate themselves and their group members based on a given set of questions. The evaluation form is made available by the course instructor at assigned time periods coinciding with the report due date. The scores for the group members are summarized by the system and become part of each student's individual grade. A further benefit of the system is that it aids in compiling and documenting ABET accreditation assessment data.

Interactive lab assistant

A web-based interactive lab assistant has been developed to supplement lab preparation and experiment procedures. The enhancement provides students with more detailed and searchable information about the equipment and procedures. A glossary is being developed to assist the search feature in this module. Touchscreen monitors are used in the lab for students to

conveniently access the application while keeping hardware and valuable lab space requirements to a minimum. Each monitor in the lab connects to a network terminal which acts as the interface to a single server computer to reduce the number of individual traditional computer workstations. Content for this system is being created for all lab experiments in the courses and is made available as it is completed.

Quizzes

Recently we have developed post-lab quizzes with the intent to better measure student comprehension and retention of their lab experiences. The students are quizzed from a pool of questions, stored in the WCMS database, pertaining to their latest lab experiment report. The quiz grade is used to help determine the course grade. Each student is asked to answer a specific number of questions that have been randomly chosen by the WCMS from the relevant pool of questions. The quiz can be taken by the student either on-line or in-class on a hardcopy handout version. If the student takes the quiz online multiple choice questions could be graded by the system automatically, but in-class and fill-in-the-blank and short answer quizzes are graded by the instructor or teaching assistant.

Course-related reference materials

Students may download (or view) certain reference materials related to the lab and lecture courses from the information stored under the "References" button. This material may include excerpts from copyrighted material used to supplement course instruction so access to it is limited to students enrolled in the related courses.

Instructor tools

The WCMS is database driven so management of it is done by modifying the database content. However, general network security concerns prevent us from allowing direct access to databases on our server, particularly for off-campus access. Several features have been developed to allow course instructors to easily manage the various components of the WCMS through the web. Not only does this web interface alleviate some of the security concerns, it also helps protect database integrity by controlling the access to the content. The instructor can add/update reading assignments, homework assignments, due dates and timely availability of solutions as well as exam answers. The instructor can easily set up time periods for which the quiz and group member evaluation applications are available at the beginning of the semester. For grading and monitoring purposes, the instructor can also view the results of the student's input for various applications.

Student Feedback

The SIUE CE WCMS is currently used in four different lab courses. Students learn the operation of the system in a class typically taken in their sophomore year. Because of the consistent navigation model and design principles used in constructing this system, the students' learning curve has been kept to a minimum. The results of random interviews with students who used the system have shown a great level of satisfaction. Students also routinely provide valuable comments for improving the system. Some of the features in the SIUE CE WCMS were developed based on these constructive comments.

Future Enhancements

Future improvements to the system include more tightly integrated data with search features to allow students to evaluate the quality of their data by comparing their data with data previously collected by other students. By doing so, students could assess the quality of the results of their experiments as well as gain experience on the appropriate range of data and results for a given experiment. Photographs of the laboratory activities and test results have been uploaded by the course instructor or teaching assistant. We are considering a way to allow students to upload this information. However, security issues have yet to be resolved before we can implement this feature. Another future enhancement is to properly manage the increasing number and size of database modules currently under the SIUE CE WCMS. Different possibilities are under investigation in order to find a more efficient and expandable way to take care of future demands.

Bibliographic Information

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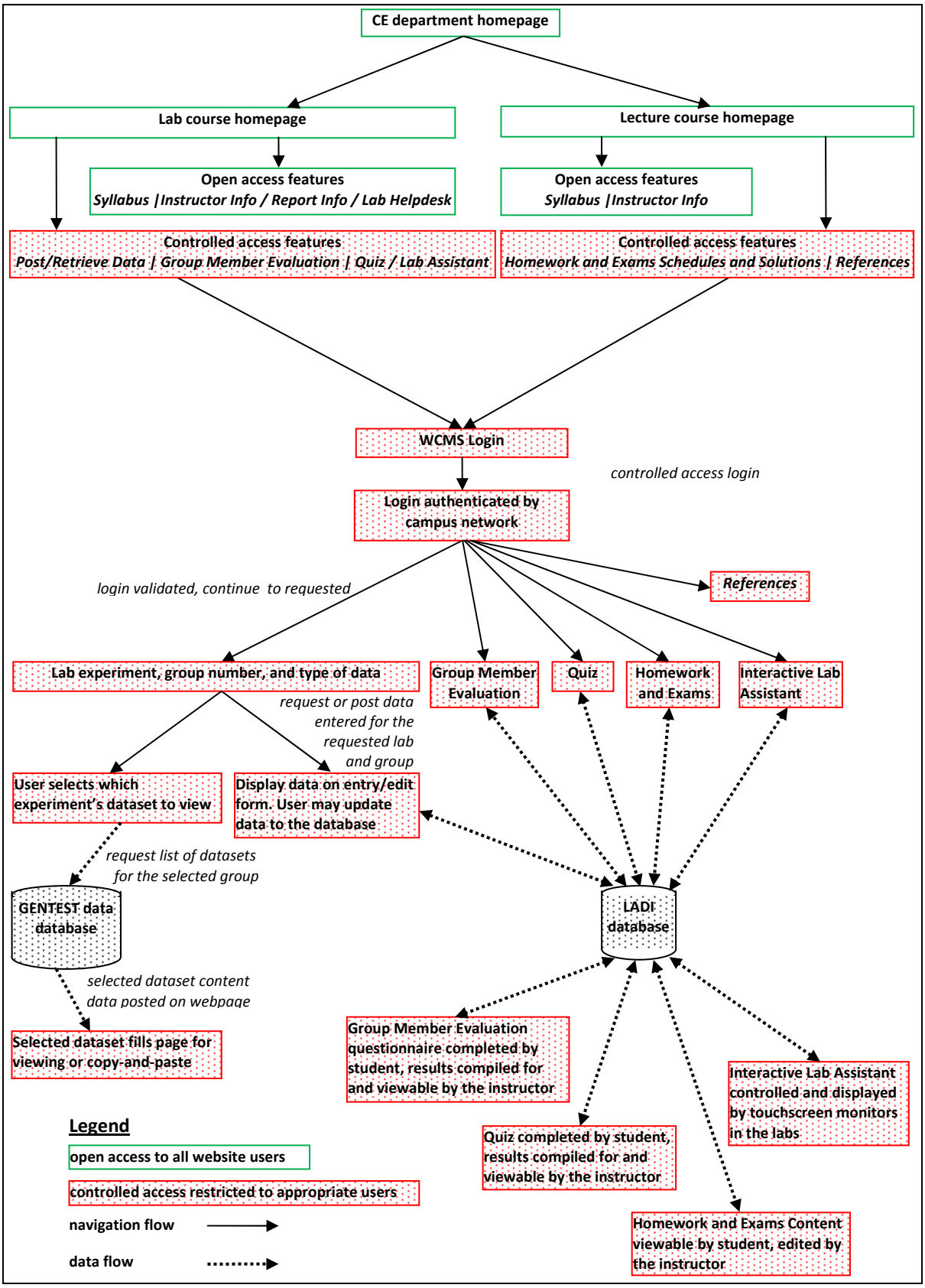

Figure 1 – SIUE CE WCMS architecture