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PREVIEW

Developing and Using Web-Based Management Systems for Large-Enrollment Courses:  
Homework, Testing, and Delivery

by

Ann Haycock

A DISSERTATION

Presented to the Faculty of

The Graduate College at the University of Nebraska

In Partial Fulfillment of Requirements

For the Degree of Doctor of Philosophy

Major: Interdepartmental Area of Administration, Curriculum and Instruction

(Teaching, Curriculum and Learning)

Under the Supervision of Professor David Fowler

Lincoln, Nebraska

May, 2001

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Homework, Testing, and Delivery

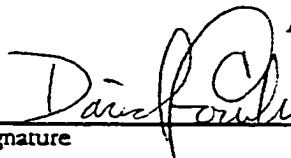
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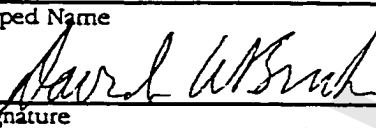
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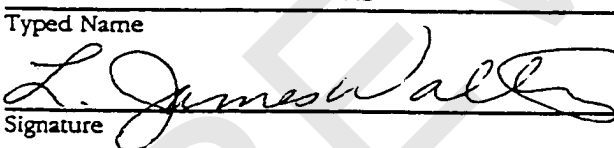
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Developing and Using Web-Based Management Systems for Large-Enrollment Courses:  
Homework, Testing, and Delivery

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University of Nebraska, 2001

Advisor: David Fowler

In the spring of 1998, an Agricultural Economics instructor identified a need for the integration of technology into the instruction of an introductory course with an ever increasing enrollment. When the enrollment was 30 students, the instructor was comfortable spending part of each weekend correcting homework assignments. However, when the enrollment reached over 150 students, the instructor sought collaboration with an instructional technologist to develop a web-based system to provide anytime, anywhere access to the homework and the feedback. Based on the experience of teaching the course for several years, the instructor felt that the weekly requirement for student response and instructor feedback was an essential element of the 'enhanced learning environment' that he had developed.

The web-based management system was developed as a rapid prototype process in response to the instructor's needs and students' feedback over a two year period. The instructional cycle was tracked through three spring semesters. The cycle progressed from the 1998 semester using all paper and pencil assignments and testing, to the 1999 semester using a mixture of paper and pencil and web-based assignments and testing, to

the 2000 semester using all web-based assignments and testing. In 1999, the instructor's concern about the impact of the technology on the learning environment led to the inclusion of weekly in-class paper-and-pencil quizzes and weekly in-class assignments. By the spring of 2000, however, the professor was comfortable with the success of the web-based management system. And all assignments, exams, and the final exam were web-based.

The literature indicates that web-based assessment systems can be beneficial to instruction in the traditional face-to-face classroom. Class time is saved, access is anytime and anywhere, and system grading saves administrative time.

The study demonstrated that a web-based management system for homework and testing can be developed by an instructor and instructional designer with limited resources. And the instructional environment of an existing campus course can be maintained throughout the integration of a web-based management system for homework and testing.

## ACKNOWLEDGEMENTS

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PREVIEW

## I. INTRODUCTION

In July, 1999, a group of the country's higher education leaders met to discuss redesigning learning environments with their focus being on the redesign of large-enrollment, introductory courses. Studies have shown that undergraduate enrollments are concentrated in relatively few academic courses. At the community college level, about 50 percent of student enrollment is in 25 courses; and at the universities, about 35 percent of the students are in those courses. Finding an approach to improving the learning environment in those courses would impact the whole institution (Twigg, 1999). This proved to be true on a smaller scale with the web-based management system for delivery of homework and testing as stated by Dr. Andrew Barkley (2001, p 28):

The success of the online homework manager has led to the adoption of the homework grader by other instructors serving over 3,000 students, and the use of the technology for class examinations during Spring semester, 2000.

The large-enrollment, introductory courses are good prospects for technology-enhanced redesign not only because they have an impact on a large number of students; but they also tend to have a standardized curriculum, and easily delineated learning outcomes. These courses provide important foundational concepts for future majors and are service courses to other disciplines; therefore if students construct a strong domain foundation in them, it will make successful transitions to more advanced studies easier. Successful redesign requires a readiness on the part of the instructor and the institution, as well as, both recognizing the need to focus on designing a learner-center environment (Norman & Spohrer, 1996).

An important question at the institution and faculty member level is how to best use all available resources that includes faculty time and technology to achieve desired learning objectives. A common sense beginning point is to integrate web-based instructional elements into existing courses (Creighton and Buchanan, 2001). The objective is for the technology systems to provide more free time for the faculty to interact with students and other scholarly activities. The web-based management system for delivering homework and tests "diminished the large commitment of instructor time and energy of grading" (Barkley, 2001). The higher education leaders view the redesign as freeing the faculty to be able to focus on creating course activities that involve the student in problem solving and interactive learning (Twigg, 1999).

That view can be supported by web-based systems that are constructed to enable greater tailoring of instruction to individual students. By providing anytime, anywhere access to homework assignments, it is both accessible and flexible and allows students to study at the times most convenient to them. Students and faculty benefit from the free time that web-based assessment affords faculty since faculty can provide individualized assistance where and when it is needed, and spend more time with student questions and necessary student intervention. This one-on-one contact with individual students is important from the mentoring point of view; and it makes the instructor more aware of the different needs of individuals, such that, students can be challenged according to their own skill levels. However, the other side of the coin is the faculty responsibility that may require extensive time, at least in the short-term; and that is the database of questions and other instructional materials that are used to provide the web-based tailored instruction

that saves the faculty member time in the long run.

Over the last few years, several commercial, institutional, and individual web-based management systems have been developed with the result being a need for a specification of criteria for a system in an academic learning environment. Gibson, Brewer, Dholakia, Vouk, and Bitzer (1995) and the Univ. of Iowa (1998) specified that the criteria should include the following:

- Testing is an important part of a system, and any such system should be judged on the basis of:
  - the type of questions supported,
  - the feedback and help provided,
  - the number of attempts that are permitted, and
  - the capability for the integration of multimedia into test questions and feedback.
- Tracking is the recording of the student's responses to homework and test questions, and maintaining a cumulative record of assignments.
- Grading capabilities compute grades on the basis of the student's response and provide feedback to the student and the faculty member.
- Tutorial building refers to whether the system supports automatic tutorial inclusion.
- Implementation criteria include ease of use and platform issues.
- Security is a necessary but very complex issue. Students must have anywhere, anytime access; however, student data must be confidential.

- Extensibility refers to the ability to reuse code modules to build similar management systems.
- Interoperability of the system and the question representation refers to the need to look to the future and develop systems that will allow for world-wide sharing of resources even though the hardware and software are heterogeneous, legacy systems.
- Interfaces: The student interface, faculty interface, and the administrative interface need to be personalized, graphical user interfaces that are easy to learn and use and provide a consistent view over time.

#### Statement of the Problem

Large-enrollment, introductory courses tend to be lecture oriented with two or three midterms and a final exam. Most of the majors do fine and the non-major students, the majority of the class, struggle through it. With large numbers of students, it is very labor intensive to grade assignments and provide written annotations of constructive feedback. Even with the assistance of graduate students it is usually a race with the clock to grade and return the midterms and grade the final exam to report the semester grade by the deadline. The first midterm is about one-third of the way through the semester and the amount of material that a student must study is daunting, with the result being that much of the learning becomes memorization.

At a minimum, three class period (a week) of a semester are consumed with the in-class midterms. Additionally, there are usually students that cannot take the exam at

the scheduled time because of illness, school-sponsored events, etc.; therefore the instructor must accommodate at least one if not more makeup exams.

If an instructor is concerned with the amount of administration associated with a midterm, the problem is compounded for smaller sets of paper-and-pencil learning material and quizzes. In-class time is required for the quizzes; and grading and feedback are necessary if the learning objective is to be achieved. The result is that there is less time for the instructor to cover the necessary material and respond to students' questions during class time.

#### Purpose of the Study

Data sets from three semesters of a large-enrollment, introductory course are compared and contrasted to determine if there were any changes in the grades as the web-based management system for homework, testing, and delivery was integrated into the course over the semesters. The first major objective of developing and using the management system was the maintenance of the "enhanced learning associated with weekly homework assignments" (Barkley, 2001).

The second purpose of the study was to describe the change in the instructional cycle that resulted from the integration of the management system into the course. The first semester was all paper-and-pencil; and the second semester integrated bi-weekly web-based homework assignments with paper-and-pencil in-class assignments, quizzes, midterms and a final exam. During the third semester, the assignments, midterms and the final exam were all web-based. There were weekly homework assignments, biweekly

quizzes, three midterms, and the final exam. The quizzes, midterms, and final exam required the students to come to a physical location, the Test Center, and present their student identification before completing and submitting the assignment. The objective was to minimize the grading and administrative record keeping for over 150 students. (Barkley, 2001).

### The Goal of the Study

First, the study is descriptive of the design and components of the web-based management system for homework, testing, and delivery in relationship to the learning and teaching processes of the course in which the system was constructed to be a supportive tool for faculty and students. Brief descriptions are provided for:

1. The student and author (faculty member) interfaces
2. The Oracle and Microsoft Access databases that store questions, answers, responses, roster information, course identification, user identification, passwords, etc.
3. Active server pages (Francis, Kauffman, Llibre, Sussman, and Ullman (1998) are the code that provides the connection between the web-interface and the database and generates the pages displayed in the interfaces.
4. Microsoft's Internet Information Server is the web server.
5. The Gradebook.



Secondly, the study tried to answer the following questions:

1. Was the existing enhanced learning environment maintained with the integration of the web-based management system for the delivery of homework and tests into the course?
2. Did the instructional cycle change as the web-based management system was progressively integrated into the course?
3. Was there a difference between the grades of students who complete the homework assignments early and those who completed the assignments at the latest possible time?
4. How did the system, that was created with very limited resources by the collaboration of a faculty member and an instructional designer to meet the needs of a specific class, measure on the criteria that has been established for commercial systems?

#### Significance of the Study

A web-based management system for homework, testing, and delivery was developed to meet the needs of a large-enrollment, introductory course in Agricultural Economics. The study demonstrated to faculty and administration that a collaborative effort between a faculty member and information technology staff can produce systems that will reduce the administrative workload of a course to free up a faculty members time to personally interact with students and other academic endeavors, and maintain the existing level of active learning. It is doable with the software and hardware that most

faculty members currently have on the computers in their offices.

### Limitations and Advantages

This is a descriptive study that takes advantage of available archival data. A preferable design would have been to have processed all 600 students in one semester by randomly assigning them to the all paper-and-pencil course, the hybrid, or the all web-based course. That was never a possibility in the existing environment. The advantage is that the data was collected, grades and statistics calculated, and stored in the database for comparison with data retained by the faculty member. The data are very accurate.

One limitation is that in a typical classroom scenario not all students complete or submit all of the homework, in-class assignments, or exams. An objective of the anytime, anywhere web access is to provide the students with every possible opportunity to complete the assignments. Using the Test Center helps with the administrative functions, but does not help with students who have a problem with being able to appear at the physical location of the Test Center.

## II. REVIEW OF RELATED LITERATURE

### Introduction

Objective tests are well-developed tools and widely used as an integral part of instructional systems design in both traditional face-to-face and web instruction. The formative evaluation of web-based testing makes students aware of their level of declarative knowledge of course material; and it provides the instructor with information about the effectiveness of their teaching. Whether the students' feedback on their learning is from the system or the instructor in class, the web-based homework and testing information can help to determine the sequence of the instructional cycle in ways not previously possible simply because of the timeliness of the instructor having the information. One of the very real values of web-based testing is the frequency with which it can be done and the immediacy of data; thereby providing faculty with the necessary information with which to refocus their subsequent lectures to address deficiencies in learning and teaching in a relevant and timely fashion (Drake, 2000).

Existing web-based homework and testing systems have widely varying emphasis as a result of being developed to meet the specific needs of an instructor, department, or institution (Whittington, 2000). Researchers have explored the general and subject-specific pedagogy of question and test design, issues of statistical validity testing and use of item response theory. Computer and paper-based tests have been compared, and web-based testing systems in distance education have been evaluated (Brusilovsky and Miller, 1999).

There are now commercial web authoring tools available that include a testing

component; however many are proprietary in nature and not available to instructors who would like to integrate only the testing component into their course without using the entire suite of embedded tools of the commercial program (Hazari, 2000). Unless the institution purchases the commercial package to be installed on the institution's servers, the individual instructors must store their homework, test materials, and student responses on the vendor's server. That is not an acceptable situation with some universities, and they will not allow student grades to be captured off campus for liability reasons. Web-based homework and testing systems can be broadly categorized according to their use of either client side or server side processing. Many of the web-based assessments for student self-assessment and motivation are client-side and there is no need to store the results for further reference. To effectively capture student responses, a server side method is necessary for authoring assignments, taking and submitting assignments, processing assignment results, and returning a feedback output in HTML format to the student and instructor. A Common Gateway Interface (CGI) has been used for a long time to implement providing server-based homework and testing; however, newer technologies are available that are faster and more secure. One proprietary technology that is readily available at no additional cost to Windows users is active server pages that run with the Windows personal web server (pws) or the internet information server (iis). Faculty members with a Windows system in their offices have the capability of the personal web server. It will handle only a limited number of connections; but it is a convenient mechanism for a faculty member to get started.

### Impact of the Web-Based Management System for the Delivery of Homework and Testing on the Instructional Cycle

Most of the cognitive-domain objectives in a course can be evaluated by web-based homework and testing with the results providing formal assessment and student self-evaluation (Charman and Elmes, 1998). Web-interfaced relational databases can generate dynamically instructional material for flexibility of time and place, updated material delivery, cross-platform compatibility, etc. Instructor and students are actively involved with changing and manipulating web-based information.

The students in large-enrollment, introductory classrooms are a mix of traditional and nontraditional students who come with a wide range of backgrounds and skills. Most of the students are non-majors so the course will not be their highest priority. Most students are under severe time constraints. Thus, there is a need to help them manage their time effectively by *encouraging frequent, short study sessions*. The increased frequency of assignments decreases the amount of material that a student has to master at any one point in time. An overlap of material between assignments reinforces the students' declarative knowledge of the topic. This type of strategy was designed to work with extremes of student capability by providing remediation and encouragement to the weaker students while providing enrichment and challenging the curiosity of the stronger students.

The strategy blends a learner-focused lecture with anytime and anywhere web access and breaks large chunks of material into simpler, shorter modules that increase long-term retention. Students interact with one another, human instructors, and

technology in ways that optimize the effectiveness of the interactions. There is no technology that can compare to the benefits of an expert human mentor who observes the learning activity and intervenes as needed, but when such a situation is not physically possible, there can be an effective blend of human and technological resources. The web-based homework and testing add an extra dimension to the active learning environment. Also, the class time spent with conventional paper tests can be spent discussing concepts that the students found troublesome on the web-based homework and tests.

The web assignments encourage students to work on course content frequently and in short sessions. They encourage students to prepare for the lecture where the instructor will provide the intellectual mentoring. The assignments are designed to test the students' comprehension of the lecture material and the assigned text material. The homework is constructed so as to encourage the student to preview the upcoming material in the textbook and review current textbook and lecture materials. It is preferable that each student receives a slightly different version of the same problem with the same concept and strategy, but different variables. The idea is to encourage students to collaborate on problem solving but also try to encourage them to work through the problems independently.

The instructor collects the students' electronic submissions, reads them, and uses the answers as discussion ideas in the class lecture as appropriate to respond to the students' demonstrated knowledge. Lectures can be customized to be more effective by tailoring the lecture and establishing a feedback loop that is beneficial to both students and instructor. The web-based assignments give the students a feeling of ownership of the

'lecture' session. The students can play a large part in determining the way the subject content is presented in the classroom. Knowing the students' responses to the subject matter, allows the instructor to engage the students at their level of background knowledge and use their answers as input for class discussion (Novak and Patterson, 1998, Rozycki, 1999, Larkin, 2001).

Novak and Patterson (1998) compare the incoming and outgoing GPAs in course sections of Physics in which the JITT, just in time teaching, strategy was not used at all, used sometimes, and used consistently in the second semester course as:

<b>GROUP</b>	<b>incoming GPA</b>	<b>outgoing GPA</b>
<b>no JITT</b>	<b>2.693</b>	<b>2.719</b>
<b>some JITT</b>	<b>2.748</b>	<b>2.800</b>
<b>consistent JITT</b>	<b>2.796</b>	<b>2.967</b>

They report that their attrition rates fell from 47% to 32% in the first semester course and from 37% to 18% in the second semester course. 94% of the students indicated they thought web-based homework assignments were a good idea. Their students commented repeatedly that the assignments helped them to learn rather than memorize, be prepared for class, and keep up throughout the semester. The results indicated significant improvement in student morale and performance in the introductory physics class where the web-based assignments provided a level of connectedness to the class that had been lacking.

### Criteria for a Web-Based Management System of Homework, Testing, and Delivery

Gibson, Brewer, Dholakia, Vouk, & Bitzer (1995) specified six principal issues that a system needs to address: testing, tracking, grading, tutorial building, implementation issues, and security issues.

#### Testing

The testing capabilities of a system focus on the types of questions that are supported, the feedback, help and hints, retries, and the use of multimedia.

#### Types of Questions

Gibson, Brewer, Dholakia, Vouk, & Bitzer (1995) define the types of questions as the categories of questions that the system supports, such as, multiple-choice, true-false, simple numeric, and simulations. Steinberg (1991) stated that the types of questions supported by a particular system are "guided by the ease of entering a response and the ability of the computer to judge the response adequately" (p 107).

#### Feedback

A web-based system can provide immediate, personalized feedback that is unbiased, accurate, and nonjudgmental. Feedback is important; and research is ongoing to find the most effective type of feedback. Hall, Pilant, and Strader (1999) studied the impact of online pretesting and feedback in an educational statistics course and their results show that the students who took advantage of the