Using Web-Based Databases in Large-Lecture Chemistry Courses

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Abstract: We describe several ways in which a Web-based database program can be used to help organize information in large lecture courses. The flow of information invariably presents a major challenge in such large courses and databases provide a powerful means to facilitate that flow. We have used Filemaker Pro software as a Web database platform. This software allows us to (1) create our own Web-based homework questions that can be immediately graded, (2) have teaching assistants report laboratory scores, and (3) provide a rapid means for keeping track of a competency-based testing scheme called Gateway Exams.

Introduction

Any instructor of large lecture courses is well-aware of the logistical overhead of managing large numbers of students. There are many schemes devised by many individuals that deal with the issues of course management, but we would like to describe how emerging technology has allowed a new form of course management. Specifically, Web-based database software allows for a relatively painless incorporation of database management tools in an academic environment. We describe three examples of the utility of this form of technology.

As educators endeavor to improve the learning of chemistry, the computer has arisen as a natural ally over the past several decades. Many of the most recent advances in the application of computers to educational endeavors have arisen from the advent of the World Wide Web[1–4]. There are a number of possible ways to utilize the Web, and not all of them involve the direct delivery of course content or chemical information. The Web also serves as a general information conduit whose capacity can be applied towards the challenges of communication within large enrollment introductory college courses. This paper reports on the use of online database software to address this aspect.

From the student perspective, few would argue that the most intense interest lies in those aspects of a course that have a direct bearing on grade outcomes. Once an examination is taken or homework handed in, this interest turns quickly to demands for scores. To wit, the posting of scores on bulletin boards is a time-tested tradition of the university scene. The expediency of affording students secure access to their academic progress that is afforded by Web-based database software again represents an important advantage.

A final means by which this use of databases can have a positive influence on instruction lies in the nature of information it can provide. Databases are well established as mechanisms by which efficient information retrieval can be achieved. In many ways better information can help instructors as well. For large-lecture environments, some grading responsibilities typically fall on teaching assistants. Concerns about uniformity of such grading with many teaching assistants have been noted for literally decades [5–7]. Ready access to grading information on a regular basis allows for early intervention if disparities arise. This type of awareness is significantly enhanced by increasing the convenience of score reporting,an aspect that is accommodated by the convenience of the World Wide Web. Moreover, even if disparity in grading is not evident, enhanced ability to check on student progress represents an advantage of this form of record keeping. Once the initial time investment is made by the instructor to institute the use of databases, the subsequent enhancement of information flow proves to be beneficial for noting trends in student performance that can inform changes in instructional approaches.

We will organize the remainder of this paper as follows. In Section II, we will discuss some technical aspects of the specific software package, Filemaker Pro that we use for our large lecture courses. We will also note security measures for keeping these records safe but accessible to students. In Section III, we will describe three specific examples of how this program has been applied in three different variations of general chemistry. In Section IV, we will note student feedback about the reliability and impact of this type of technology use on student attitudes and learning. Finally, in Section V, we will summarize and draw conclusions about our experience with implementing this form of do-it-yourself Web technology in our general chemistry courses.

Software Needs and Details

We have chosen Filemaker Pro, Version 4 as our software for this project. This package is particularly useful because it has its own Web server utilities and it connects well with an HTML editor, Home Page, made by the same company, Filemaker Inc. Like any database package Filemaker Pro requires the user to define certain fields that will hold data. This process, along with making connections to forms for a Web page, constitute the majority of what one must learn to make use of this technology. We will describe these features of the software first and then note ways to incorporate password protection and other security features.

When the Filemaker Pro software is loaded onto a Macintosh (this program is also available for Windows

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Table 1. Types of Fields in the Filemaker Pro Software Package

Name of Field Type	Type of Information
Text	Text fields are used for storing names, answers to questions, etc. Any text-based question or input is appropriate.
Number	Number fields are used when the data entered are pure numbers, such as a score on a quiz or a numerical answer to a question.
Calculation	Calculation fields allow formulas to be used, much like they are used in spreadsheet programs, calculation fields also allow for password protection by using Boolean comparison to a stored password file.
Date	Date fields can be automatically entered and they provide for extra security features.
Time	Time fields also can be automatically entered to help provide both enhanced security and a means to monitor due dates for Web-submitted homework.

environments), it has a number of ready-to-use templates that can provide some useful guidelines for new users. What we do instead is draw up a rough sketch, by hand, that includes all of the information we believe will be important to include for a given usage of a database. If, for example, we are going to develop a student registration database, we determine all the types of information we wish to know about the students. Invariably this information includes some student choices about options in a course (even for things as mundane as laboratory sections), but we often take advantage of the fact that students will be making such choices to inquire about backgrounds in chemistry or intended majors. So long as the interface on the Web that is encountered by the student is relatively easy to use, we have found that students are generally willing to provide information requested in optional fields.

Having decided on what data we wish to obtain in our database, we then build the appropriate locations, called fields, in Filemaker Pro. Each piece of data we obtain is located in a specific field; thus, generally we have separate fields for last name and first name, for example. For our applications there are several types of fields that are commonly used. Table 1 provides information about these fields. We will outline the specific uses of these fields in the examples we present in the next section. It is, however, important to note from the outset that each field in the database, regardless of type, is named and the precise name is important. The field name (for example, last_name) provides the means by which the Web page accurately passes information to the database. A typographical error in a field name will result in the loss of data entered via a Web-page form.

In addition to the definition of the type of field, Filemaker Pro software allows specific constraints to be established for fields. For example, last_name can be set as a required field. If the last name is left blank on the form that is submitted, an error is returned and the student must try again. A field can also be forced to be unique. A student ID number, for example, is valid for only one student and so this field is typically set to be "unique." Some fields are also defined as "unstored." Such fields are usually calculations that verify some component of the data entered, but do not need to be kept. For example, on a quiz we can check to see if an answer is within some expected range by carrying out a calculation in an unstored field. This type of check is usually done to catch typographical errors or other user difficulties. This basic feature can also be used to check passwords or to verify that students are signed up for some specific option within a course (to submit online homework, for example).

Once a database has been conceived and constructed, the next step is to design the form for the Web page that students or teaching assistants will access. This process is facilitated for the use of Filemaker Pro software by designing pages with Home Page software from Claris. The latter package has a connection assistant that helps build forms that link correctly to the database. This connection-assistant feature includes a few graphical templates that result in visually sensible Web pages once the form is constructed; thus, this pairing of programs results in an interface for the students that is professional in appearance.

Having designed a database and a Web form to fill in the data, the only remaining task lies in making these pieces available on the World Wide Web. The Filemaker Pro software package includes a component called "Web Companion" that allows the database to be broadcast over the Web. Various possible security settings can be used to protect the database from unwanted infiltration. For example, it is possible to limit the access to specific Internet IP addresses. This type of security is actually setup with HTML IF statements inside of the Web page that provides the form for the database. The language used is called CMDL and Filemaker exclusively processes these statements. This methodology is much easier to learn than Java scripting or even Perl processing [8]. Limiting submission to only one set of IP addresses is not the only advantage of CMDL, but it provides the best example of this methodology within the context of our use of databases in the large-lecture chemistry courses. Thus, when we use the databases for TA reporting of laboratory scores, for instance, not only do the TAs use a password to gain access they must do so from a computer located within the chemistry building subnet.

Once a database is created and made available on the Web, each time a form is submitted that database is updated. We generally include hidden fields in our forms that store the date and time of the submission without the user knowing they are there. (Other uses of hidden fields include entering ID numbers and names when only a username and password are entered by the student.) To analyze information in the database requires only that the faculty member have access to the computer that is running Filemaker Pro. Formats for the way the information is viewed are easily adjusted. Common manipulations such as searches, sorting, or calculation of averages are also easily accomplished. Moreover, data contained in these databases may be readily exported to spreadsheet formats; thus, grades reported to the database by a TA can be quickly uploaded into a spreadsheet for class grade keeping. Files can also be exported in HTML format to allow easy creation of score-posting Web pages.

Before proceeding to examples, we wish to note security issues that arise in the use of Web-based reporting of information. Users of the Web regularly raise security concerns, and when student grades may be involved, the need for security is enhanced. We note that a common practice of hard-copy backup of information remains a good idea with databases, just as it does when using computer spreadsheets.

With regard to security for the Web-based databases, there are three primary mechanisms by which security may be invoked.

First, there is a security feature in the Web Companion module of the Filemaker Pro software. Specific user names and passwords may be assigned through this security feature. The establishment of these user names and passwords requires the instructor to enter them manually at the computer that is hosting the database. We normally access this level of security for reporting tasks that are carried out by teaching assistants. Each TA who will report grades is explicitly added to the password security listing and their password is assigned. The TA cannot change this password via the Web. It is, however, important to note that many Web browsers will store passwords in cache memory. Thus, if a TA provides the appropriate password, enters scores, and then leaves a browser open at a general user computer workstation, security may be compromised. Any person who uses the browser before it is shut down will have the correct username and password submitted automatically upon entering the Web page that contains the score update form. We obviate this concern by both training the TAs to be sure to quit the browser and explicitly reminding them to do so when they finish entering scores. They are prompted after submitting a form with scores as to whether they wish to enter more scores, or quit. If they answer quit they are linked to a page that vividly reminds them to quit the browser so they do not compromise security. We also note that the hidden date and time fields help us to know when unusual activity might occur. Every time a record is added or modified in a database, a time is recorded, so unauthorized entries can be eliminated by checking for entry times.

A second form of security, one that we usually use for student-accessed databases, involves a password lookup from an established registration database (RD). When students register for the Web-assisted component of the course they submit a username and password that is stored in the RD. If students wish to look up scores they may do so after entering through a form that requests their username and password. When this form is submitted, it invokes an unstored calculation field that is a Boolean comparison of the entered name and password to those stored in the RD. If this comparison returns a value of "true," the scores of that student can be identified (via another, hidden lookup of the student ID number) and displayed. Such search functions provide powerful functionality that may be designed using the Connection Assistant component of the software. This type of search is limited to two fields of the RD and it is important to specify that exact matches are required. In our initial implementation of this scheme, we neglected to specify exact matches and students were able to gain entry using a blank for passwords. Because matches are exact, we note one important constraint for this form of security is the apparent inability of the Filemaker Pro software to handle nonalphanumeric characters in the comparison. Many students have been wisely trained to include such characters in passwords, but they must be told to avoid them for this Web-assisted portion of the chemistry course.

The third and final component of the security is associated with the ability of browsers to have bookmarks that might compromise security. If a TA were to create a bookmark in hopes of speeding the entry of data, for example, that bookmark could be used by somebody else to gain similar access. We eliminate this possibility with the use of a simple Perl script in our Web pages that requires the database access to originate from a specific page. This script will automatically link to an error page if the required pathway is not followed (either by use of a bookmark or by direct typing of a URL). Thus, we force our teaching assistants or students to follow a path that includes the password protection components of the software. We have found these three security features to provide adequate protection for information obtained via the Web. We do not contend that they would divert a serious and dedicated hacker, but our belief is that our information is not sufficiently valuable to such people as to make their efforts worthwhile, and thus we feel comfortable with the security as we have constructed it. Our students generally feel comfortable with this level of security as well.

Examples of Database Usage in Large Lecture Courses

To provide a more detailed understanding of the needed components of Web-based databases and their value, we will discuss three uses in large lecture courses at UW-Milwaukee. These three uses provide a range of examples, but not an exhaustive list of the ways we have used the technology. We will first note how the databases were used to facilitate TA grade reporting. Then we will discuss online homework assignments designed around these databases, and, finally, we will describe our use of databases in a competency-based testing innovation called Gateway Exams[9].

TA Grade Reporting. Grade reporting from teaching assistants always involves organizational efforts and the use of Web-based databases can help this process by allowing secure submittal of scores from a distance. The nature of database entry does place a constraint on this use, however. Specifically, using a Web form connected to a "submit" button limits the updating of records to a single student, or conversely a single laboratory section for one week. Each time the form is submitted the database is updated and every field in the database is included in the update. If one wishes to construct a traditional record, where each student has a record with a score, the input of data needs to be done one student at a time, at least in Version 4 of the software. We have not updated to the new version of the software, which reportedly allows data entry of an entire set of data, such as the grades for an entire section, in a single submitted action.

We facilitate this process for the teaching assistant by advancing from one student to the next automatically. Thus, if a laboratory section has 18 students, the TA experiences the following steps. First, they enter a Web page that they access by directly typing the URL. This site has no linking page to it, so it is largely invisible to the public and is protected by a simple Java password script. After entering the password, they enter a page that has all laboratory sections listed. By clicking on the link for any laboratory section they encounter a second, TA specific username and password pop-up window and are then transferred to the data-entry forms for that group of students. We require our teaching assistants to enter data in this way every three weeks. Thus, upon entering the data form, the TA is asked for attendance and score marks for student 1 (arranged alphabetically) in this laboratory section. The TA fills in the data in the form and clicks on submit. At this point, the database is updated and the information just entered is displayed to the TA, who can check it for accuracy of

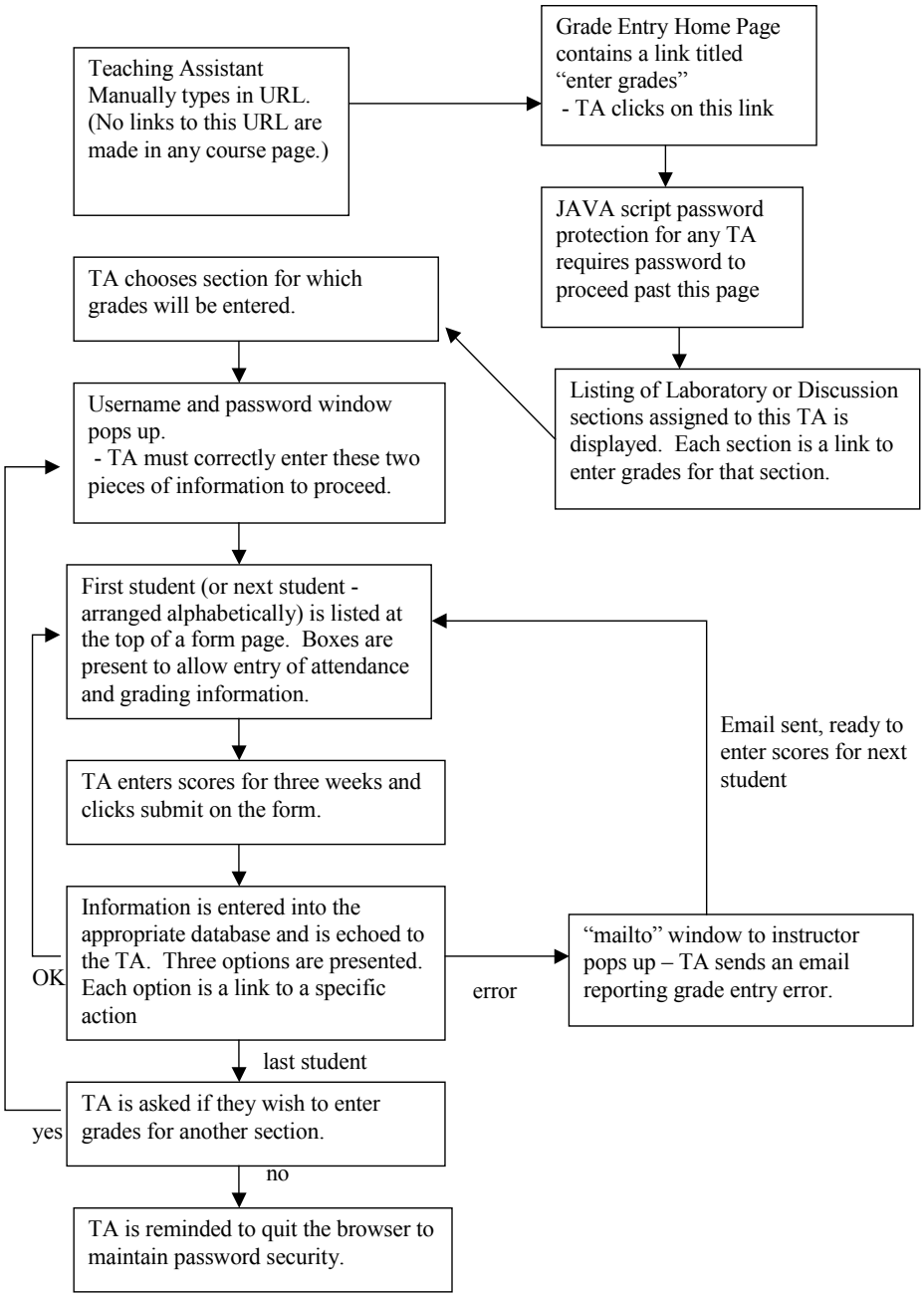

Figure 1. Flow Chart of TA Grade-Reporting Activity.

reporting. They answer the question "Is this information for 'student 1' accurate?" If they click "yes" they are transferred to the form page again, but this time for student 2 and the process iterates until they enter all data. If they click "no" they enter a "mail-to" page where they report to the instructor the error, so the instructor can adjust the database manually. Upon entering the "send on the email" command they are transferred back to the grade reporting form for student 2. A flow chart showing these steps is provided for added clarity in Figure 1.

This use of databases is in some ways cumbersome to implement. Teaching assistants tend to prefer handing in a diskette or hard copy of their grades and find the Web method to be extra work. This perception by TAs motivated our choice of reporting grades three weeks at a time, to reduce the number of instances of students needing to submit grades. The need for manual corrections of the database because of incorrect data entry has been very small, one instance in over 500 grade reports submitted. Overall, once the teaching assistants are properly trained, this method works well. In situations where there is regular turnover of teaching assistants from one semester to the next, the need for extra training tends to mitigate against this usage. It is also important to note that recent software improvements in Filemaker Pro suggest that further improvements of this scheme for TA score reporting could be readily devised, allowing the reporting of all 18 student grades for a single laboratory or quiz in one form.

Table 2: Fields in a Database for a Five-Question Homework Set

ID Number	000-00-0000
Username	Tholme
Last Name	Holme
First Name	Thomas
Q1	B
Q2	A
Q3	A
Q4	D
Q5	C
A1	B
A2	B
A3	A
A4	D
A5	C
P1	2
P2	2
P3	2
P4	2
P5	2
Total points	8[a]
Date	04/22/00
Time	11:06:34 am

[a]Calculated field by the equation, tot_pnts = ((if(q1.eq.a1)*p1) + (if(q2.eq.a2)*p2) + (if(q3.eq.a3)*p3) + (if(q4.eq.a4)*p4) + (if(q5.eq.a5)*p5))

Online Homework Assignments. Another prominent usage of the Filemaker® Pro software package is in the design of do-it-yourself online homework. While there is increasing availability of support packages from textbook publishers or software companies for electronically based homework systems, for some educators the prospect of controlling assignments more integrally is attractive. In our case, because we obtain regular feedback from students in class [10], we can design homework questions that are chosen specifically to induce extra study in areas of weakness, and these areas do not always match what is provided by commercial ventures. The Filemaker Pro software, along with Claris Home Page, allows for easy construction of homework problems ourselves. That they are automatically graded allows us to provide more rapid feedback to students and alleviate some grading burden for teaching assistants.

From a student perspective online homework represents an optional part of our courses. Because we tend to have students from diverse backgrounds, some strong and others rather weak in chemistry or with missing pieces, we allow students to choose at the outset of the semester to either do online homework or challenge problems. Challenge problems are done only three times during the semester, while online homework is done weekly. In our experience, relatively few students elect the challenge option, but if they do they can still see the homework questions, they simply cannot submit answers for points towards a grade. The choice for this option is part of the registration page that we have students fill out early in the semester. Students also provide usernames, passwords, and posting codes at the time of registration.

For a student who chooses the online homework option, they encounter the following weekly routine. On Wednesday mornings, the new homework problems are posted under the appropriate section of the course home page. Most students go to the page and print out the problems (see our student survey below). They work on the problems over the next two days and are required to submit their answers before midnight on Friday night. When they submit the answers they are told their score on the homework, clicking the submit button updates the database and invokes a score calculation and a Web page that prints out the score calculation is the response page for the submit button. If a student tries to submit a second time, they receive an error, because their username is keyed to their student ID number, which is unique. If a second entry is attempted the database returns an error and students are told they have not updated their score. This feature does cause some difficulty when students double click on the submit button. The second click is perceived by the database as a second submission and the students see the error page, in some cases so soon after their score is provided that they never see the score page. We include explicit warnings to avoid the double-click and tell students what the error message means when they do receive it. If they are uncertain about their score, they can email the instructor who can look up the score easily. It is also possible to set up a shadow database that contains information about student scores that they can check using their posting codes. We will provide additional information about this feature in part C of this section.

For an instructor the majority of the time spent getting online homework running using the Filemaker Pro software is invested at the outset of a course. We have generally used templates with 5, 10, 15, or 20 questions, although any number of questions can be included. If the same number of questions is used each time, the posting of a new homework set is made easier, because databases can be copied rather than built from scratch. Table 2 shows the database fields of a five-question online homework set that uses multiple-choice questions for the individual items. Multiple-choice questions are NOT required, though for automatically graded assignments they are much easier. Students could easily enter numerical answers also and automatic grading could be accomplished; though issues of typographical errors and other difficulties would seem to be more prominent in these cases.

Looking at the database itself, we see that the student name and ID number are entered automatically, based on their use of the password to access the homework problem. The answers for the five questions are next, followed by automatically entered fields containing the correct answers for each question. The next five fields all contain the number 2, our assignment of points for each question. Clearly any values could be placed on each question, we always used two points to make each five-question homework worth a total of ten points. The next field is the calculation of the total points earned by the student. It compares the submitted answers to the correct ones and multiplies by the question value for each question, then sums over all questions. The comparison function returns a 1 for a match and a 0 for a mismatch. The final two fields are automatically entered, the date and time, which allows us to make sure the assignment was submitted on time.

This example provides a detailed look at how we design a database to meet our specific needs. In this case, because we wished to have the assignments graded automatically, it required that we insert extra fields that contained the correct answers and point values of the questions. Even with these extra fields, when we use the connecting feature between Filemaker Pro and Claris Home Page, the form correctly requests fields for only the answers the student will submit.

We place these answers within table structures in HTML for layout purposes. Because we use multiple-choice answers, we use radial buttons as the means for indicating answers. Radial buttons within the same question cannot have two answers, (unlike check boxes) so they are most appropriate for the way we construct our questions. The types of questions we used in a first semester general chemistry course can be viewed at the web site listed in reference 11. In some cases we use questions published in test banks and in other cases we write our own questions based on student feedback about topics presented in lecture.

How does this type of exercise influence student behavior and performance? We have several observations and comments on this question. First, we note that UW-Milwaukee is an urban, largely commuter school. Our students commonly do not interact with each other outside of laboratory or discussion sections. The advent of online homework assignments brought a noticeable change in this atmosphere for our course. Because many students went to the computer laboratory in our Departmental Learning Center to download these assignments, they formed study groups out of proximity (of both location, the learning center and task, the homework). We believe this shift in student behavior is an important benefit of the online homework. This benefit, however, is quite difficult to measure. Second, there was some collusion on the part of student groups to enhance overall scores on homework. When some particular question was controversial, some groups would rotate the student who would submit their homework first. The remaining students in the group would then learn which option was correct, and when their assignments were submitted, they benefited from the group work in a more tangible, and somewhat unethical way. If one wishes to avoid this type of behavior, scores could be posted for the entire class according to student ID numbers in HTML format after the due date has passed. When asked, however, students as a group did not consider this tactic to be wide spread. This type of difficulty is similar to the establishment of fraternity files where students save questions from year to year. Unfortunately, this technology does not provide a means for avoiding such student tactics, and the time tested method of changing questions remains the best option for this longer term difficulty. Finally, the online homework seemed to have a submission rate that behaved quite like regular homework assignments. Early in the semester, most students submit homework, but the percentage of participating students decreases as the semester proceeds. This observation is not surprising, but it does suggest that there is little additional benefit associated with the glitz of the online homework. Students still perceive it as work that they may not have the time to do. We'll note other student perceptions and performance measures in the next section.

Tracking for Competency-Based Examination Grading. Another instance where the online database usage is vital in our program lies in keeping track of grading records in a competency-based grading scheme called Gateway Exams. While this program is explained elsewhere [9], we will provide a brief overview to establish the utility of the database programs. The Gateway Exam scheme is implemented in a separate course taken by pre-engineering students. In discussions and surveys of engineering faculty, we have identified specific problem-solving concepts and strategies that are commonly learned in general chemistry that are directly useful in subsequent engineering courses. We assess these problem-solving skills separately using a competency approach where students must demonstrate 80% proficiency on two separate exams, but may retake either exam until they do. Students who pass both Gateway Exams are rewarded in terms of their grade such that they are quite likely to pass the course and continue with their engineering curriculum. This scheme, therefore, essentially says to engineering faculty, "the Chemistry course provides the skills you expect it to provide as a minimal expectation and students who pass are likely to have advanced their problem-solving skills." Subsequent courses can presume this capacity.

This teaching tool supposes a competency approach that involves the possibility of multiple retakes of similar exams. The flow of information that is required to successfully implement this scheme is somewhat complicated. Students need ready, convenient access to their scores. Examination proctors need not only scores but also must identify what examinations have already been taken, so that students are not given the same exact exam twice. The Filemaker Pro database software presents a clean solution to these multiple needs.

As in the electronic homework example, students are asked to register for the option that includes the Gateway Exam. The vast majority of students elect to attempt the Gateway Exam, and when they register, they acquire three key identifiers, a username, a password, and a randomly assigned Gateway ID number. When the registration database is updated, it also spawns an additional database that is essentially a copy of several fields from the registration database. This shadow registration database allows for separate look-up functions for students while the instructors and proctors have look-up access to the main database. This dual storage of information is readily afforded in terms of hardware, as storage space is plentiful even on PC-level machines.

When Gateway Exams are administered and corrected, the instructor or proctor must input scores one student at a time. Database entry is gained via Gateway ID number, rather than username or student last and first names, because it tends to be quicker. Data input for each student consists of the entry of a Gateway ID number. When it has been entered, a new screen returns the name of the student associated with that ID to verify the correct records are being updated. The individual who is entering scores verifies the student identity and all scores recorded thus far for that student are displayed. New scores are added by entering the Gateway Exam number (test 1 or 2), the number that identifies the specific test taken, and the score on that test. Those values are entered in the main Gateway score database. After each student, the proctor is asked to indicate whether or not more scores are to be entered. Either response ("Yes" or "No") results in a copy of the record being made to the student accessible, shadow database. When the Gateway Exam is administered in class and there are many scores to be entered at once, it requires significant time to submit a form for each student. During the retake phase, however, the individual student input requirement is not onerous.

When a student wishes to see scores, they gain access to only their scores (not the examination identifier numbers) by entering their username and password. When they click the submit button, the searches required to display scores are

Table 3. Survey of Student Opinion Concerning Online Homework Assignments

Questions	Response 1	Response 2	Response 3	Response 4	Ave
Doing the homework assignments on the Web helps me in this class.	A lot 15[a]	Some 58	Not much 17	Not at all 10	2.22
In my experience, the technology for Web homework is ___ reliable.	Always 24	Sometimes 56	Not often 17	Never 3	1.99
To do Web homework, I print out the questions and come back to submit answers.	Always 93	Sometimes 6	Not often 1	Never 0	1.08
I work with other students when I do the Web homework.	Always 32	Sometimes 33	Not often 15	Never 19	2.21
Doing the Web homework helps me to keep up in the course.	Always 20	Sometimes 53	Not often 18	Never 8	2.14
Cheating on Web homework is a ___ problem in this class.	Huge 9	Big 24	Modest 55	Nonexistent 13	3.07
The number of points assigned in this course to Web homework is	Not Important 8	Too much 25	Just right 55	Too little 13	2.73
I spend ___ doing the homework in an average week.	< 1 hour 15	1–2 hours 53	2–3 hours 24	>3 hours 8	2.25

[a]Numbers listed here are number of student responses that indicate this answer.

conducted in the shadow databases, thereby protecting the officially recorded scores of the students, and eliminating the possibility of having students determine information about examination identification numbers. By contrast, when instructors access the information, they pass through additional security and then all of the fields are displayed because searches are conducted in the original databases. Proctors, therefore, can readily identify the versions of the gateway exams that have already been taken by a given student and give them a different version.

This database structure allows the type of facile information flow that makes competency-based examinations feasible, even in large lecture sections. Students have convenient access to their scores, which they appreciate, and instructors have enough additional information to allow smooth operation of the retake scheme. What have we learned about the way databases affect students? Our results from various assessments are presented next.

Student Assessment of Database Usage

Of the three forms of database usage we have presented here, the one that is received with the least enthusiasm is the reporting of grades by teaching assistants. Many of our TAs have experienced the relative convenience of occasional hardcopy reports as the required means of communication, and they feel that the online reporting takes significantly more effort that clicking on the print button. Nonetheless, once we were able to limit the reporting to every third week, the TAs who participated in this pilot project felt the work was readily accomplished. Because only four TAs were involved we did not conduct any formal survey of their perspectives. The impressions that we present here were formed through an informal interview process with those TAs.

The Gateway Exam project is a rather new implementation of the online database technology, and we have not conducted any separate research into student perception of the databases in this context. We have included student impressions of the database as part of the overall student evaluation of the Gateway Exams and can report on that aspect here. In addition to the informal input we receive from assisting students with registration or other interactions with the database, we included a statement about the score-posting database component of the Gateway Exams in our survey of student attitudes. This statement, "The way scores for the Gateway Exams were posted and accessed on the Web was a good way to get the information" received stronger agreement than any other statement in our 13-question survey. (More results from this survey have been published elsewhere [9].) The agreement with this statement was equally robust among students who passed two Gateway Exams (and thereby derived direct benefit from them) and those who did not. This type of agreement between groups of students was seen in few other categories. Thus, our indication from students is that the online database was in some sense the best component of our Gateway Exam innovation.

We have carried out more detailed studies of student opinion of online homework constructed using the databases. Our primary evaluative tool is again a survey of student opinion, this time taken online in a preparatory chemistry course taught by a colleague. This survey was presented after 40% of the semester had passed and students had completed six homework assignments and 100 students completed the survey. We present the survey and the student responses in Table 3.

This survey approaches the homework from the perspective that it is designed to be a normal component of the course. The goal of the online component is to use a new technology to make homework more convenient for both the instructor and the student. Within this framework the student response is notably favorable. For the most part, they find the homework helpful (question 1) in numbers that mirror regular paper and pencil homework. They tend to find the technology component of the database usage reliable (though we must admit our survey design with choices being either "always" or "sometimes" reliable perhaps provided too coarse of a response scheme for this statement.) Nearly all the students do the homework in (at least) two trips (question 3), printing it out first and then returning to submit answers. A majority of students find the online homework helps them keep up in the course (question 5) a response that, again, is likely similar to traditional homework. The students are not particularly worried about cheating on this form of homework and the details of points and hours required to accomplish the

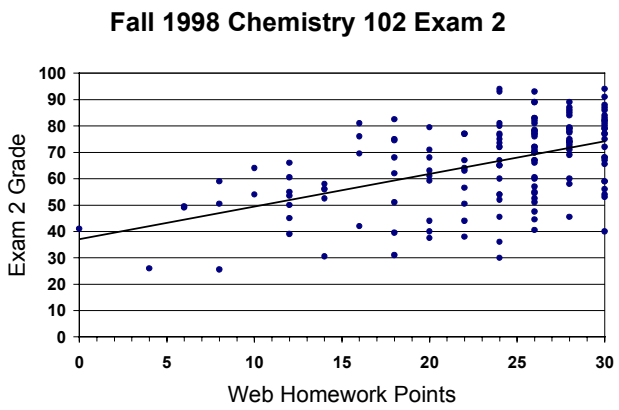

Figure 2. Student performance on exams and homework.

assignments also seem within reason. The only question with a rather wide distribution of responses was the one that asked the students if they worked in groups on the homework (question 4). Again, this response seems typical in terms of student attitudes we have witnessed for group work in discussion sections at UWM.

The overall conclusion of this survey, therefore, is that the online homework can be incorporated seamlessly into an introductory course. Every other indication we have encountered, through surveys or informal feedback, also reveals a student attitude that such online work is simply a normal usage of new technology. Student performance on examinations as a function of homework scores reveals that doing well on homework does not particularly mean that the examination will go well, but it does tend in that direction, ever so slightly. Figure 2 shows a plot of student homework points versus test points for one group of students on one examination. This plot is typical of each such plot we have ever constructed for the online homework's effect on test performance. There is considerable scatter in this plot, but a best-fit line has a positive slope (better homework results in better test scores) with a quite weak correlation value for the linear fit. While we have never carried out the formal study, this type of relationship seems to mirror the benefit of graded, traditional homework assignments, at least in our experience with them. Certainly, we can suggest that the online homework does not appear to do any harm to student performance. This observation is important, because our implementation of the online homework utilizes multiple-choice questions, and some faculty perceive that such questions are less beneficial than open-ended questions.

Summary

This paper has presented the use of database software to move several components of the large lecture, general chemistry course to the World Wide Web. We have utilized a general database software package, Filemaker Pro in conjunction with the HTML editor HomePage to implement this scheme. By using a very general software package, we can readily adapt and customize the application to our particular interests. In addition to summarizing a few technical aspects of the software that have important implications for its use in this context, we have provided three examples of ways in which we have used this software. The reporting of laboratory scores by teaching assistants, the delivery of homework assignments online (with automatic grading), and the tracking of competency-based examinations serve as an introduction into the possible uses of this type of computer technology. Student response to the introduction of this form of technology has been markedly positive. In every style of student feedback that we have collected, the primary observation is that students perceive the on-line databases as normal components of the course. The technology is not the message; it is merely another way to enhance communication of information or deliver course content to the students. Once an instructor has invested in the training required to use this type of software, the implementation of the technology is not complicated and it does serve to enhance the speed with which information can be gathered and/or transmitted within a large lecture course environment.

Acknowledgment. Initial work with the Filemaker Pro software was conducted in conjunction with a project funded by the Camille and Henry Dreyfus Foundation. Without the learning we accomplished there, we may not have implemented the schemes presented here. The Gateway Exam project and our use of databases within that project have been supported by the National Science Foundation under grant DUE-9752280.

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