WEB-BASED SOFTWARE INTEGRATION FOR IT TRAINING AND SKILL ASSESSMENT TOOLS WITH THE UNIVERSITY INFORMATION TECHNOLOGY EXAMS

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Abstract

As the need for computer literacy continues to grow in both the business and academic settings, the majority of universities have begun to add computer literacy courses to their academic programs. One of the major problems encountered in designing the syllabi for these courses comes from the wide variety in freshman students’ computer backgrounds. One way many universities address this problem is to offer an IT Placement Exam. Upon passing this exam, the student can then take more advanced IT courses. Some academic programs also require students to pass a more challenging IT exam before graduation to ensure that they maintain their computer skills at a professional level.

Currently, Auburn University offers two IT exams, the COMP1000 Placement Exam and the IT Business Exam. The Placement Exam serves as a pre-requisite for more advanced IT courses and is administered through WebCT, whereas the IT Business Exam serves as a skill assessment before graduation and is administered through SkillCheck. However, the administration and student registration
processes for both exams are frequently cumbersome and lack security measures for accessing sensitive data (e.g. user id, password and e-mail address). The exams are in need of major improvement, which is the main focus of this project. The problems associated with WebCT and Skillcheck will also be addressed. The Proposed design for the improvement will be implemented to produce a web-based application, which will be integrated with better IT training and assessment tools.

The software components involved in this project are ASP, VBScript, ADO, SQL Server 2000, and Prentice Hall’s Train PH Generation IT & Assess PH Generation IT, a web-based IT training and assessment application.
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Chapter 1

INTRODUCTION

The modern world is constantly changing and computer technology products continue to evolve at a fast pace. The need for computer literacy continues to grow as we begin to engage these technology products in a meaningful way in both the business and academic settings, and computer literacy has become no longer a luxury but a necessity [1, 2, 3]. Because of this trend, the majority of universities have begun to add computer literacy courses to their academic programs [2, 3]. One of the major problems encountered in designing the syllabi for these courses arises due to the wide variety of students’ computer backgrounds, especially for freshman students. Some students already have quite an extensive background with computers when they arrive, whereas others have only a very limited or no background with computers at all. One way many universities address this problem is to offer an IT Placement Exam. Upon passing this exam, the student can then take more advanced IT courses. Some academic programs also require students to pass a more challenging IT Exam before graduation to ensure that they have maintained their computer skills at a professional level.
Currently, the Department of Computer Science and Software Engineering of Auburn University offers an introductory computer application course, namely COMP1000 Personal Computer Applications. This course teaches students some of the fundamentals of computer applications such as IBM PC, Microsoft Windows 9x, Internet Explorer, and Microsoft Office 2000. Students who take this class are either seeking to enrich themselves by expanding their knowledge of the Windows application fundamentals that will help them with their jobs in the future, or to fulfill part of their graduation requirements. Normally, students who take this course receive sixteen weeks of intense training in the fall or spring semester or ten weeks in the summer session.
1.2 WebCT and Placement Exam for COMP1000

Some students need to take COMP1000 for graduation but cannot fit it in their study schedules, or simply do not want to spend such a large amount of time for this class. Under the current school policy, Auburn University offers an alternative solution to this problem, which is the COMP1000 Placement Exam. Students are exempt from this graduation requirement if they take and pass this exam with a seventy percent or above grade. Since the COMP1000 Placement Exam can only be taken once, students who have failed to pass this exam must take the COMP1000 course in order to fulfill this part of the graduation requirements.

WebCT is a web-based software product developed by WebCT, Inc. that Auburn University has been using for the past few years for administering the COMP1000 Placement Exam. Although information about the exam can be accessed and registration for the exam can be done on any computer that has an Internet connection, the exam can only be taken at the SB101 laboratory on Auburn University campus. The reason for such a restriction is to ensure that the students who are about to take the exam are the actual students who have registered for it, and not some of their friends or relatives who could help them pass the exam. Furthermore, the COMP1000 Placement Exam is currently administered on Fridays during any academic term, except on holidays. There are usually about six exam sessions available per exam date during the fall and spring semesters and about four or less during the summer term. Each exam session starts at the top of the hour. Each exam consists of 50 multiple-choice questions and lasts about 50 minutes, and the questions are based on the topics covered in
COMP1000. Students receive their exam score immediately, and if they have passed the exam with a 70 percent (35/50 questions correct) or above grade, they can print a score report out and give that to their academic advisor as proof that they have taken and passed the exam. They also keep a copy of the score report for their own records. Nevertheless, there are some problems associated with this WebCT software, which I will address in the following paragraphs.

First, WebCT currently only allows multiple-choice questions to be administered as the method for the COMP1000 Placement Exam. However, this is not the best way of assessing students’ skill for the computer fundamental subjects taught in COMP1000. In other words, multiple-choice questions only test a student’s skill based on how well he has memorized information about the subjects tested, and not how well he would perform using the information, which in reality is what is needed in a real job situation. For example, a multiple-choice question certainly could not ask students questions like “Please change the font size of the following paragraph from size 12 to size 14 and font type from Times New Roman to Arial” or “Place a table with a size of 4 columns by 4 rows at the top of this Word document.”

Second, the current login procedure for students taking the Placement Exam is a long process, in which students first have to go to the COMP1000 official website, then follow a few links before eventually getting to the WebCT login webpage for taking the Exam. Then, students log in with their SSN, create a new WebCT account, and finally go through more links before they can actually take the Exam.
Third, we currently limit the number of students to be fifteen per exam session, although we have about forty computers in the SB101 laboratory. The reason for this size limitation is that since the login procedure is such a long process, the proctor must be able to help each student within a reasonable amount of time (usually within five minutes) to guide him or her to the right webpage to take the exam so that each exam session can be completed within the one-hour time frame. However, the current exam registration interface for the Placement Exam does not prevent student registration for multiple exam sessions. This means that a student could actually register for all of the six exam sessions on an exam date and just show up for whichever exam session he or she feels like on that day. This could create some serious problems, because a single student then takes up sessions that are needed by other students. This is especially true towards the end of the semester, when more students try to register for the exam, some of whom need to take and pass the exam to fulfill part of their graduation requirements.

Fourth, the handling of student registration and testing information is presently quite a cumbersome process. Student registration information (e.g. student name, SSN, e-mail address, password for the test, etc.) must to be downloaded from the web and rearranged into the right comma-separated format file (which takes quite a while to do) and saved for uploading to WebCT later on. Then, after the file is uploaded to the database of WebCT, there is an initial password issue that must be resolved before the upload is complete. Then, after students have taken the exam, their scores are downloaded, and these again need to be rearranged into the right text format for uploading to the mainframe computer.
1.3 SkillCheck and IT Exam for the Business School

SkillCheck Professional Plus is skill-based assessment software for Microsoft Office 2000 developed by SkillCheck Inc. The Department of Computer Science and Software Engineering of Auburn University currently uses it under license. SkillCheck has no training options, but consists of approximately ten modules of questions for skill assessment, covering areas including Office suite, Windows 9x, Browsers and Computer Literacy etc. Also, it allows students to answer questions by performing tasks in a simulated Microsoft Office application environment. Each module contains over one hundred interactive questions per Microsoft Office application. Instructors can select and compose an exam from questions on the same topic but with different levels of difficulty (beginning, intermediate, and advanced), from questions of different topics but with the same level of difficulty, or from some combination of the two.

SkillCheck has been used at Auburn University to administer an exam called the IT Business Exam since the summer of 2001. This exam is designed specifically for business majors at Auburn University, and the purpose of the exam is to guarantee that the business students maintain their skills at a proficient level before graduation. The exam consists of only Microsoft Excel questions, but at a more advanced level than those used for the Placement Exam. So far, SkillCheck has proved to be quite successful in assessing student’s skills on Microsoft Excel, based on the feedback from the business professors and students who have taken the exam.
SkillCheck uses Microsoft Office Access as its database to store user registration information, exam scores, etc. Although SkillCheck has a utility function that allows the importing of student registration data, it offers no other utility functions that would allow the exporting of student score data as delimited format files, for example. However, Windows Scripting Host (WSH) with Jscript can be used to handle the task of exporting score data from the Access database to a MySQL database that is used for both student registration and exam score storage.

**Figure 1** shows the administration interface currently used for the IT Business Exam. Under “Dump database as CSV file”, the administrator or academic counselor can retrieve from the database all the student registration information (by clicking the “Dump User Table” button) or all the student score information (by clicking the “Dump Score Table” button on the interface) as comma-separated format files for further statistical analysis with programs such as Microsoft Excel. However, this interface presents some problems. First, as more students register for the exam and more student scores are stored in the database, it will become impractical when, for example, a counselor would only like to look at student scores for a specific test date or time period. Second, the current interface does not offer a feature that would allow counselors to take a quick look at an overall student score report to see the number of students who have passed or failed the exam and what the scores are during a specific time period. Third, this interface does not offer a feature that would allow exam administrators to add and delete the exam dates and times. This is especially important for the exam dates, which are different every semester. In the past, these tasks have been done manually by changing the dates and times in the script that generates the interface.
Figure 1. Current Administration Interface of IT Business Exam

Download Registration File

Select Date:
2000-04-30

Format:
- Comma Separated Text
- XML (under development)

Download

Upload Exam Results

Upload this file: Browse... Upload File

NOTE:
Only files which meet certain CSV or XML format could be properly processed.
Use the script provided to create these files please.
Manual editing/composing is not encouraged.

Dump database as CSV file:

dump notes table
dump lean table

Student Profile

User ID:
Get Student Profile
Fourth, after a student has created an account, confirmation e-mail with his registration information is sent to the student. In that e-mail, a reply e-mail address is included in case the student has any questions about the exam. The reply e-mail address is usually the e-mail address of the administrator who is on duty at the time. However, the current administration interface does not provide any option to update this information, which has to be changed manually from the scripts. Fifth, the current scripts for the administration interface do not check for correct score file header before uploading into the database. This means that the wrong file can easily be uploaded by mistake and as a result the student score is not stored in the database at all. To make things worse, once the wrong file is uploaded, the administration interface has no way to reverse the mistake, except through a painstaking procedure of going into the database, changing some of the values in the table that is used to store student score information, then returning to the administration interface and trying to upload the correct file. If the score file uploading is unsuccessful for some unknown reasons (as has happened in the past), then the same painstaking procedure must be repeated until the correct score file has been uploaded successfully.

Figure 2 shows the student registration interface for the IT Business Exam. The scripts that are used to handle the registration information provided by students suffer from several flaws. First, the scripts do not check for extra spaces, non-alphabet characters (e.g. numbers such as 1,2, and 3 and punctuation marks such as comma, period, and question mark), and special characters (e.g. %, $, #, and &) that do not constitute students’ last and first names. This flaw has caused problems in the past. For example, there was a student who typed in
Figure 2. Current Student Interface of IT Business Exam
“Lin, III” instead of “Lin” as his last name when he was creating an account. The extra field and the comma, which is “, III” in this case, made the WSH/Jscript create an extra field in the exporting score file that resulted in his score not being stored in the MySQL database.

Second, the scripts generate the initial password for a student when he first creates an account for exam registration, although he can change it later on. However, the scripts do not limit the number of characters in the new password. This means that he can be creative by typing in “Annieismygalandllikeherverymuch” as his new password, which is really unnecessary.

Third, after a student has provided the new user registration information, the scripts do not generate a validation or confirmation page for the student to check whether he has made any mistakes (e.g. incorrect spelling). This can be a problem, as the current interfaces only allow him to change the password part of the registration information (he cannot change his name and e-mail address) after the account has been created. So, this increases the burden on the exam administrator who has to go into the database and help those students who have made a mistake, which they would probably have caught and corrected if a confirmation page was included in the registration process.

Fourth, after a student has created an account, the initial password is sent to the e-mail address he has provided during the new user registration process. However, the scripts provide no checking for correct e-mail format. For example, an e-mail address such as linjack or linjack@auburnedu (notice the absence of the dot between auburn
and edu) would both be registered as “valid” e-mail addresses. If this were to occur, the initial password would never reach the student, preventing him from logging in and registering for an exam session.

Lastly, both the administration and student interfaces are not currently running under a secure environment such as under the secure socket layer (SSL) protocol. Since information such as an administrator or a student’s login id and password and a student’s name and e-mail address are all sensitive data, a protocol such as SSL is needed to prevent “packet sniffing” by hackers.
Chapter 2

SOFTWARE COMPONENTS FOR INTEGRATION

With the fast development and production of new computer applications essential for PCs, such as those from Microsoft (Microsoft Office XP, Windows XP, etc), Auburn University needs to constantly keep its skill assessment testing material up-to-date so as to keep a competitive edge for its graduates. Unfortunately, SkillCheck will no longer support the new Microsoft Office XP skill assessment testing. Hence, Auburn is currently preparing to switch to a new generation of software called Train PH Generation IT & Assess PH Generation IT, or PHIT for short, which will be the main focus of this project. Also, the aforementioned problems associated with the WebCT and Skillcheck will be taken into serious consideration in the design and implementation of this project. Due to some complicated internal issues currently involved with the Placement Exam, this project will focus on the IT Business Exam only. The main focus of this project is not only to streamline and improve the whole process of exam administration and student registration for the IT Business Exam but also to improve the security issue so that the process can be conducted in a more secure environment. The result of this project will produce web interfaces integrated with PHIT. The software components involved will be described in detail in the following sections.
2.1 Train PH Generation IT & Assess PH Generation IT

Prentice Hall’s Train PH Generation IT & Assess PH Generation IT (PHIT) is a web-based software for both Microsoft Office 2000 and XP developed by InfoSource Co. and Prentice-Hall, Inc. It is a new generation of software capable of both training and skill assessment. The training part of the software is called Train PH Generation IT, whereas the skill assessment part is called Assess PH Generation IT. Currently, the department of Computer Science and Software Engineering of Auburn University is in the process of integrating this software, which will replace SkillCheck in the fall of 2002, with the university administrative systems for future training and testing for both the IT Business and IT Placement Exams.

Train PH Generation IT & Assess PH Generation IT includes Office 2000 and XP, Windows 2000 and XP, Internet, etc. for training and testing. For the training part, students work in a simulated Microsoft Office 2000 or XP application environment in which the program guides them step by step as they become familiar with a particular task, such as how to save a Word file, how to clear cell content from an Excel worksheet, or how to open and view an Access database object. The formats of the tasks in the training exercises are a mixture of multiple choice, true/false, matching, fill-in-the-blank, order-of-process (in which available answers are put in the right order by “dragging” each answer and “dropping” it to its special answer holder on the screen), click or hot spot (by marking the answer with an X mark with a single click of mouse button on the screen), and skill hands-on. The main difference between the first five task formats and the last format is that the former are more like objective, memorized types of questions, whereas the
later are more like skill assessment types of questions, in which one can explore the simulated application environment before completing an intended task. The latter style of questions are designed to help students train in a way that is closer to a live environment, but eliminates the need to spend a significant amount of money to do the same training with live applications.

For the testing part, instructors can set up an exam in the forms of pre-test, post-test, test, and quiz consisting of questions with various degrees of difficulty, although PHIT does not specifically categorize them as beginning, intermediate, and advanced levels of questions as SkillCheck does. The questions from the test banks are strictly skill hands-on.

Since PHIT is web-based, unlike SkillCheck, this would give students the convenience of training themselves wherever and whenever they like, as long as the computer terminals used have an Internet connection. However, the remote computers would first require the installation of the Authorware Web Player, a web-based software developed by InfoSource, Co., before they can be used to access the contents of PHIT. Second, since students would train and test themselves in a simulated environment, they do not need to spend extra money to buy these applications, which are needed in a real-time environment, as I have mentioned earlier.
2.2 Active Server Page

Active Server Page (ASP) is a technology developed by Microsoft great for creating dynamic web pages [4]. One advantage that dynamic web pages have over static web pages is they can be customized to suit an individual user’s need. Although static web pages are convenient for providing general information about the exams, such as exam policy, length of the exam, and so forth, they cannot provide a more interactive and personalized experience, such as registering or canceling an exam, or viewing exam registration and/or score history. They also do not allow professors or administrators to perform statistical analyses of the exam results.

Active Server Page code is browser-independent [4]. Since dynamic ASP code (denoted by the <%...%> tags or server script delimiters) is processed on the web server by the ASP script engine to generate pure HTML pages, the client (browser) does not need any ASP support, and these HTML pages can be viewed with ease by different versions of Internet Explorer and Netscape Navigator, as well as other browsers. Second, this server-side technology allows programs to be run in programming languages (e.g. VBScript) that are not supported by the client. Third, this allows a quicker loading time because the client is actually downloading a page of pure HTML instead of relying on client-side dynamic web technologies such as Java applets or ActiveX controls to process the page information, which slows the loading time. Fourth, since ASP code is processed on the server side, the client can never view its content, thus improving the security of the system. In addition to these advantages, browser incompatibility issues (i.e. lack of client-side dynamic technologies for older versions of
browsers), which result in web pages not being displayed correctly or not being displayed at all, are avoided.
2.3 VBScript Scripting Language

Active Server Page supports quite a number of scripting languages including Microsoft VBScript and Jscript, PERL, and Python, which can be use for creating dynamic web pages [4, 5]. A sample ASP code (with VBScript) is illustrated in Figure 3. VBScript was used in this project mainly because it is a subset of Visual Basic programming language that is easy to understand and master [6, 7]. Due to the time constraints on the project, VBScript was the best choice. Some of the ASP objects and VBScript features that were heavily exploited in the project are shown in Table 1.

Figure 3. A Sample HTML Page with Embedded ASP/VBScript Code

```html
<html>
<head>
<title>Embedded ASP Code</title>
</head>
<body>

<% Dim getCurrentTime
     GetCurrentTime = NOW
     Response.Write GetCurrentTime %>

</body>
</html>
```
Table 1. Major ASP Objects and VBScript Features Exploited

<table>
<thead>
<tr>
<th>ASP Objects</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Request</td>
<td>Retrieve input (e.g. student registration info) from an HTML form</td>
</tr>
<tr>
<td>Response</td>
<td>Write input into an HTML</td>
</tr>
<tr>
<td>Server</td>
<td>Database connection</td>
</tr>
<tr>
<td>Session</td>
<td>Store sensitive data of user (e.g. password and e-mail address)</td>
</tr>
<tr>
<td>NewMail</td>
<td>Send a copy of the student registration information to the student</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VBScript Features</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option Explicit</td>
<td>Prevent variables from being declared accidentally</td>
</tr>
<tr>
<td>On Error Resume Next</td>
<td>For error handling</td>
</tr>
<tr>
<td>RegExp Object</td>
<td>Pattern recognition (e.g. check for correct input format such as user id, password, and e-mail address)</td>
</tr>
<tr>
<td>String Functions (e.g. Left, Right, Mid, Trim, Split)</td>
<td>String Manipulation (e.g. parse input file and remove extraneous space characters from an input string)</td>
</tr>
</tbody>
</table>
2.4 ActiveX Data Objects

Open Database Connectivity (ODBC), a standard for accessing data, was designed to allow the programmer to access information stored in databases with a common set of routines, regardless of which type of database is used to store the information, or where the information is stored [4]. However, ODBC works under the assumption that all sorts of database applications store information using the same structures, which are tables, records, and keys. Since data can be stored in different formats, such as Word documents, Outlook Express Email, or Excel Spreadsheets, something other than ODBC is needed in order to access that kind of data. Hence, Microsoft developed a technology called OLE-DB [4, 8]. OLE-DB is faster and easier to use than ODBC. Also, it supports access to a much broader range of data storage types than ODBC does (Figure 4). Unfortunately, not all languages can access OLE-DB directly because it is a very low-level model [4, 8]. This means that scripting languages like VBScript and languages like Visual Basic are not powerful enough to manipulate OLE-DB objects, although languages such as Java and C++ are. Therefore, Microsoft developed a higher-level model called ActiveX Data Objects (ADO) to solve this problem [4, 8]. ADO is much easier to use than OLE-DB because it simplifies some of the complexities of programming with OLE-DB. Furthermore, languages such as Java and C++ that can use OLE-DB directly can also use ADO to simplify their data access. In the overall structure, the ADO layer sits between the application itself and the OLE-DB layer (Figure 4). In this project, ADO objects (e.g. Connection and Recordset) will be used explicitly with the ASP/VBScript code to pass data between the ASP page and SQL Server 2000 database.
Figure 4. Overall Structure for the Universal Data Access

Applications

- C++
- VB
- Script
- Java

ADO

OLE - DB

ODBC

- ODBC Data
- Access
- SQL Server
- Oracle
- Exchange
- Excel
2.5 SQL Server 2000

SQL Server 2000 was selected for this project because first, Prentice Hall’s PHIT software uses it to store its information, and it would thus be much easier to integrate software with the university administrative systems if SQL Server 2000 is also used for this purpose. Second, SQL Server 2000 has its own ad hoc SQL Query tool [9]. This Query tool is user friendly and allows much quicker building of database solutions than Sybase does, for example. Due to the time constraints on this project and as PHIT uses it, SQL Server 2000 appeared to be the best choice. In addition to the basic SQL commands such as SELECT, INSERT, UPDATE, and DELETE that are used with the ADO objects to access information from the SQL database, the CONVERT function is used heavily mainly for its special date formatting capabilities (e.g. for comparing exam date and time) [10].
Chapter 3

Design and Implementation of the Web-Based Application

3.1 Architecture Overview

3.1.1 Physical Layout

This project will produce a web-based application. This means that exam administration, exam registration, review of the grade report, and training for the Office suite applications can be done via a browser from any computer with an Internet connection. However, students must take the exam in the designated COMP1000 computer lab (currently in SB 101) in the presence of the proctor to ensure that the person taking the exam is the actual student who has registered for it and not one of his friends or relatives attempting to pass the exam for him.

The Microsoft Windows 2000 and Internet Information Server 5.0 (IIS 5.0) with ASP 3.0 and VBScript and Jscript 5.0, Microsoft SQL Server 2000, and PHIT are all currently installed on a new lab server (host name: ebola.eng.auburn.edu) that has been acquired solely for this project. However, due to the installation of upgraded versions of PHIT software by Prentice Hall and InfoSource in the new server from time to time, the ASP with VBScript code for the web-based application of this project has been stored in the more stable University FrontPage server (host name: frontpage.auburn.edu or ducnt45.duc.auburn.edu), which has just been upgraded to the same operating system and server software as that used by the new lab server. The SQL database tables

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for this project have also been stored separately in the University SQL server (host name: ducnt07.duc.auburn.edu). The COMP1000 computer lab (SB 101) currently has a LAN with about 42 client machines running Windows 95 with Office 2000, but these will be replaced by better and faster computers before the fall semester of 2002 starts. The computer lab also has a server running Linux. The Linux server communicates with its clients through the Samba protocol, whereas the new lab server uses the HTTP protocol. The traffic will be confined within the Auburn University Campus Network. The physical layout described above is illustrated in Figure 5.
Figure 5. The Physical Layout of the Web-Based Application

SB101
42 client machines/Win 2000
Linux/Samba

Ebola.eng.auburn.edu
Frontpage.auburn.edu
Ducnt07.duc.auburn.edu

AU Campus Network

The Internet
3.1.2 Logical Layout

From the logical point of view, SQL 2000 Database Server will provide both front-end and back-end data storage. Active Server Page with VBScript will provide the interface for the data storage and control data input and output. The student registration data is first stored in the administrative SQL database. After students have registered for an exam through the student registration interface, their registration data will be automatically transferred into the PHIT’s SQL database, although PHIT provides the importing option of student registration data as delimited format file. This would eliminate the extra time spent on manually uploading the student registration information into the PHIT's SQL database with its importing utility function. After students have taken the exam, the score results are converted into a delimited format file by the PHIT before they are transferred back into the administrative SQL database through the administration interface. Finally, all of the student registration and exam score data are deleted from the PHIT’s SQL database. In this sense, PHIT’s SQL database operates as a temporary data storage system. Therefore, the data collected in the administrative SQL database would represent both students’ registration and grade information. This information could be retrieved via students’ and administrators’ web interfaces, which will be the main focus of this project. Figure 6 shows the logical layout.
Figure 6. The Logical Layout of the Web-Based Application

- Administrative SQL Database
  - Data Exchange
  - ASP/Web Server Registration Rules
    - Register
    - Student
    - Attend Exam
    - Data Exchange
    - Report
    - Admin
  - PHIT
    - SQL Database
3.2 Design and Implementation Detail

3.2.1 SQL Server 2000 Database Table Design

The Office of Information Technology (OIT) has created a SQL 2000 database called ITExams on the ducnt07.duc.auburn.edu SQL server for this project. In the ITExams database, two main tables are created to store student registration information and exam scores, respectively. A third table is created to store the administrator’s id, password, and e-mail address information. These three tables with their column name, data type and their purposes for this project are shown below (Tables 2 – 4).

**Table 2. IT User Information**

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Data Type</th>
<th>Length</th>
<th>Allow Null</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student_ID</td>
<td>int</td>
<td>4</td>
<td>No</td>
</tr>
<tr>
<td>First_Name</td>
<td>nvarchar</td>
<td>255</td>
<td>No</td>
</tr>
<tr>
<td>Last_Name</td>
<td>nvarchar</td>
<td>255</td>
<td>No</td>
</tr>
<tr>
<td>User_ID</td>
<td>nvarchar</td>
<td>50</td>
<td>No</td>
</tr>
<tr>
<td>Email</td>
<td>nvarchar</td>
<td>255</td>
<td>No</td>
</tr>
<tr>
<td>Password</td>
<td>nvarchar</td>
<td>15</td>
<td>No</td>
</tr>
<tr>
<td>Department</td>
<td>nvarchar</td>
<td>100</td>
<td>No</td>
</tr>
<tr>
<td>Enroll_Date</td>
<td>datetime</td>
<td>8</td>
<td>No</td>
</tr>
<tr>
<td>Last_Login_Date</td>
<td>datetime</td>
<td>8</td>
<td>No</td>
</tr>
</tbody>
</table>

Student_ID: Track number of students in the database. The primary key of the table.

First_Name: Student’s first name. This is a required field for the PHIT database.

Last_Name: Student’s last name. This is a required field for the PHIT database.

User_ID: Student’s AU Global ID. Student needs this for login in order to register for an exam or access his score.
Email

Student’s e-mail address. This is used to send a copy of the student registration information to the student. Also, this is needed when a student forgets his password and wants to retrieve it. This is a required field for the PHIT database.

Password

Student’s password. Student needs this for login in order to register for an exam or access his score data. This is a required field for the PHIT database.

Department

Student’s major department. This is a required field for the PHIT database.

Enroll_Date

The date when student first created an account

Last_Login_Date

The date for the most recent access of student’s account

Table 3. IT Score Information

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Data Type</th>
<th>Length</th>
<th>Allow Null</th>
</tr>
</thead>
<tbody>
<tr>
<td>User_ID</td>
<td>nvarchar</td>
<td>50</td>
<td>No</td>
</tr>
<tr>
<td>Planned_Date</td>
<td>datetime</td>
<td>8</td>
<td>No</td>
</tr>
<tr>
<td>Planned_Time</td>
<td>datetime</td>
<td>8</td>
<td>No</td>
</tr>
<tr>
<td>Actual_Date</td>
<td>datetime</td>
<td>8</td>
<td>Yes</td>
</tr>
<tr>
<td>Test_Name</td>
<td>nvarchar</td>
<td>50</td>
<td>Yes</td>
</tr>
<tr>
<td>Test_Duration</td>
<td>nvarchar</td>
<td>50</td>
<td>Yes</td>
</tr>
<tr>
<td>Test_Score</td>
<td>int</td>
<td>4</td>
<td>No</td>
</tr>
<tr>
<td>Test_Grade</td>
<td>nvarchar</td>
<td>50</td>
<td>Yes</td>
</tr>
<tr>
<td>Test_Status</td>
<td>nvarchar</td>
<td>50</td>
<td>No</td>
</tr>
</tbody>
</table>

User_ID

Same ID field, corresponding to table IT_Users.

Planned_Date

A scheduled exam date that a student has registered for. Valid date is controlled by ASP code.

Planned_Time

A scheduled exam session or time that the student has registered for. Valid time is controlled by ASP code.

Actual_Date

The date the exam is actually administered or taken by the student. This value comes from the PHIT’s delimited format score file.
Test_Name: The name of the IT Business Exam for a particular exam date. This value comes from the PHIT’s delimited format score file.

Test_Duration: The amount of time the student spent on the exam. This value comes from the PHIT’s delimited format score file.

Test_Score: The score percentage the student received on the exam. This value comes from the PHIT’s delimited format score file.

Test_Grade: Denotes whether a particular score percentage is a passing or failing grade. This value comes from the PHIT’s delimited format score file. “p” stands for pass and “f” stands for fail.

Test_Status: Indicates the current exam status for the student. “Scheduled” means the student has just scheduled an exam. “Pending” means the student is taking an exam. “Not Attend” means no-show of the student for an exam. “Graded” means the student has taken an exam and received a grade for it.

Table 4. Exam Administrator Information

<table>
<thead>
<tr>
<th>Admin_Users</th>
<th>Column Name</th>
<th>Data Type</th>
<th>Length</th>
<th>Allow Null</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Admin_ID</td>
<td>Nvarchar</td>
<td>50</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Admin_Password</td>
<td>Nvarchar</td>
<td>50</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Admin_Email</td>
<td>Nvarchar</td>
<td>255</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Admin_Level</td>
<td>Nvarchar</td>
<td>50</td>
<td>No</td>
</tr>
</tbody>
</table>

Admin_ID: Exam administrator’s login id. Currently, there are 2 pre-assigned IDs, one for CSSE and the other for Business.

Admin_Password: Exam administrator’s login password. Currently, there are 2 pre-assigned passwords, one for CSSE and the other for Business.

Admin_Email: Current exam administrator’s e-mail address. Any student who has questions about the exam can send a message to this e-mail address.
| Admin_Level | Used to distinguish between the CSSE and Business administrators, who have access to their own administration interfaces. |

Furthermore, there are two small tables, one of which is used to store exam date data and the other to store exam hour or session data. These two tables are designed to speed up the exam scheduling process instead of having to go into the scripts to change them if this information is hard-coded into the scripts. The above database table descriptions are for the IT Business Exam. As I have mentioned earlier, this project will concentrate on the IT Business Exam only.
3.2.2 Improving Efficiency of Data Exchange

The main focus of this project is not only to streamline and improve the whole process of exam administration and student registration for the IT Business Exam, but also to improve its security so that the process can be performed under a more secure environment. The problems and issues associated with the current administration for both the Placement and IT Business Exams, discussed earlier in Chapter 1, will be addressed by the web-based application produced for this project.

For the exam administration side, any CSSE exam administrator on duty will be provided with a pre-assigned administration ID and password so that they will have access to the administration interface. He can change the password if he wishes or use the current one. If he has chosen to change the password, it is his responsibility to pass this new information to the next administrator on duty. He must also update the administrator’s e-mail address information to his own since students who have questions about the exam will send messages to this e-mail address. The administrator’s ID and level will remain fixed and cannot be changed from the administration interface.

Before the exam is administered in a semester, the administrator on duty has to schedule it before it becomes visible on both the administration and student interfaces. The new web interface allows the administrator to schedule or cancel exam dates and sessions. However, once at least one student has registered for a particular exam date or session, this exam date or session cannot be deleted from the interface. If this exam date or session has been scheduled by mistake or must be moved to a different date or time for some reason,
then the student registration information for this exam date can be retrieved from the interface. An e-mail message is then sent to those students informing them of the change so that they can register for a different but available exam session.

The new web administration interface allows the administrator to access all or some of the student records (e.g. registration and score data) either as a delimited format (crude data straight from the database) or a HTML format (e.g. a formatted report with percent ratio of pass and total number of students who have taken the exam). The new interface also allows the administrator to look at a particular student record and register the student for an exam at the last minute, which cannot be done by the student from the student interface since it is a requirement for the student to register for the exam more than 24 hours before it is actually administered.

There are direct data exchanges between the administrative SQL database and PHIT. A student’s registration data will be automatically retrieved from the administrative SQL database and transferred into the PHIT's SQL database once a student has registered for an exam through the student registration interface. This also allows the student to log in to PHIT and take the training exam or module before he comes to the designated lab to take the actual exam.

After students have taken the exam, their score data will be exported out of PHIT’s SQL database as a delimited format file and uploaded into the administrative SQL database so that the students can access them conveniently through the student web interface. The format of the
delimited file for the score data is illustrated and explained in the following (Table 5).

### Table 5. Student Score Report

<table>
<thead>
<tr>
<th>TYPE:</th>
<th>Delimited Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAS HEADER FIELD</td>
<td>YES</td>
</tr>
<tr>
<td>FIELDS OR HEADER IN ORDER</td>
<td>Student</td>
</tr>
<tr>
<td>SAMPLE DATA</td>
<td>Linjack, Jackson Lin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student</th>
<th>A student’s user id and full name.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson/Test</td>
<td>The name of an IT Business Exam.</td>
</tr>
<tr>
<td>SC</td>
<td>Score Complete. This is the score percentage for the student.</td>
</tr>
<tr>
<td>TY</td>
<td>Type. The exam can be set as a pre-test, post-test, test, or quiz. The exam will be administered as a test, denoted by capital letter “S”.</td>
</tr>
<tr>
<td>AT</td>
<td>Attempt number (for the exam). It will always be 1, since the same exam cannot be taken more than once.</td>
</tr>
<tr>
<td>ST</td>
<td>Status. “p” means passed and “f” means failed.</td>
</tr>
<tr>
<td>Time</td>
<td>Time spent in the exam.</td>
</tr>
<tr>
<td>Last Attempt</td>
<td>Date-stamps last visit. This is the date of the exam administered and taken by the student.</td>
</tr>
</tbody>
</table>
The delimited format file containing students’ score data is also stored in a secure directory in the Frontpage.auburn.edu server for backup purposes in case something goes wrong with the database. Finally, the students’ registration and score information stored in the PHIT’s SQL database is deleted. The reason for such action is that the PHIT’s SQL database only serves as temporary storage for student’s registration and score information for the exam, and this information does not need to be stored in its database longer than necessary.

From the student registration side, a student needs to provide the required information (e.g. first name, last name, user ID, password, e-mail address, and department) in order to create a student account before he can register for an exam. After all of the required information has been provided by the student, a confirmation page with the required information is shown to the student. This enables the student to check for any mistakes that have been missed by the ASP/VBScript, such as misspelling of the student’s name and password, although the ASP/VBScript does a certain degree of checking for correct e-mail address and password format, no space or special character for the student’s name and so forth.

Once the account has been created, the student is only allowed to change his password for the registration part of the information. It should not be possible for a student who has failed the exam to be able to update his name to someone else’s or one of his friend’s who has passed the exam, for example, as he can then retrieve this information and inform his academic advisor that he has passed the exam, whereas in fact he has not. Moreover, the student can only register for one exam session at a time. Also, he is only allowed to register for an
exam session more than 24 hours before it is actually administered. If the student has made a mistake in choosing his exam session, he must first cancel it before he can register for a different session. In case the student forgets his password, he can retrieve it by providing his user id and e-mail address information. Then, a copy of his registration information, along with his password, will be sent to his e-mail address.

Furthermore, once the student has registered for an exam session, he is automatically granted access to PHIT so that he can take the training exam and module before the actual exam takes place. The student can see his exam score right after he has taken it. The score data is also made available through the student interface within 24 hours of the exam. If the student has failed the exam, he can go to the student interface and register for another exam session. Currently, there is no limit set for the number of attempts that a student can have for the IT Business Exam. In other words, he can take it as many times as necessary until he has passed the exam.
3.2.3 Security Issues

Since the web-based application produced in this project will be used to access sensitive data such as a student’s name, user id, e-mail address, password, score data, etc., security must be maintained at a certain level. The ASP/VBScript codes that generate the application are kept in a directory on the Frontpage.auburn.edu server, which only the OIT and the application developer (in this case, myself) has access to. In the future, these ASP/VBScript codes will be made available to the exam administrator on duty and to anyone working to improve the application. Also, since the ASP/VBScript codes are processed on the server side, the client side will not be able to see any of the source codes other than the resulting HTML pages.

The SQL 2000 databases for the PHIT and the web-based application can be accessed on the client side with the client side tool, Enterprise Manager, from the Microsoft SQL Server 2000 package. Again, only the database system administrator and the application developer have access to these databases currently. They will also be made available to any exam administrator on duty and to anyone working to improve the application.

The exam administration and student registration process will be performed with a secure protocol, namely Secure Socket Layer (SSL). This means that it is virtually impossible for the transmission of encrypted sensitive data such as administrator and student login information (e.g. user id and password) over the network to be captured by a hacker [11].
3.2.4 Session Control

Although web server has a stateless connection with the browser via http, some kind of session awareness is needed for the user’s convenience. For instance, it is not desirable for the user to have to provide his login id and password for every HTML page he visits during the administration or registration process, which will involve sensitive data such as student id, password, e-mail address, and exam score. This session awareness can be implemented by means of either cookies or hidden values. Hidden values are good for less sensitive data, such as exam date and session, but not for user id and password because they are visible in the HTML source code from the browser. Therefore, cookies are the solution generally used to address the session problem. ASP’s Response object has a Cookies collection that can be use for this purpose [4]. However, the information stored in the cookie will persist for as long as the browser is open. This could create some potential problems. For example, a student can log in his account, access some score information and decide to take a break. He may have left the browser on while he is taking the break. During this time, anyone who has access to his computer has access to personal information about this student and can change his password, cancel his exam session and so forth. Fortunately, ASP has a Session object, which works in the same way as a cookie does, except with the addition of a timeout value [4]. This means that if no web activity by the user (e.g. a request or refresh a page) has been detected after the timeout period expires, then the information stored in the Session object is automatically cleared. If this happens, the user would be asked to log in his account again regardless of whether or not the browser has been kept open. The major drawback of using the Session
object is that it consumes server memory resources. Since the server will have to use its precious memory resources to monitor and wait for the period specified by the timeout to determine whether or not to terminate the session, the timeout value should not be set too long. Likewise, this timeout value should not be set too short, because it could expire before the user can complete his tasks. Generally, a 20 minute timeout is a good compromise value.
TESTING AND RESULTS

This web-based application has undergone extensive testing to remove some minor bugs and to make sure all of the improved functionalities implemented operate correctly. So, far, no major design flaws have been discovered. A user guide for the IT Business Exam administration and instructions for student exam registration will be formulated before the PHIT will enter service in the fall semester of 2002. However, beta and stress testing have not yet been conducted. This process, which is due to commence very soon, is necessary to discover any remaining bugs and to determine the maximum number of concurrent users that the PHIT application can support without noticeably slowing the server. This number needs to be at least 15, because that is the size of each exam session for the current IT Business Exam.
Chapter 5

FUTURE WORK

It is anticipated that this project will be extended to include the Placement Exam in the future. The web-based application developed for the IT Business Exam will be similar to that for the Placement Exam. However, the application will need to have a better identification validation measure for a student who plans to take the exam, since the Placement Exam is equivalent to a full course, unlike the IT Business Exam. In order to confirm that a student is indeed currently a student at Auburn University, the application would need direct access to the mainframe computer (which stores student SSN, grades, etc.). However, the most difficult part of this student identification validation is the application incompatibility issue between the web-based application and the mainframe. Also, access to the student data from the mainframe computer is strictly limited to senior personnel such as system administrators and academic counselors. Permission to work on such data for a graduate student like myself would need to be granted at different levels or would not be granted at all. However, if such permissions are granted, extreme caution will definitely be needed so as not to corrupt or disclose the data in any way.
References


