

Yuehong Wang: AIMS Online Testing System, An Interactive Web-Based Testing System For Medical School Courses. A master's project for the M.S in I.S Degree. July, 2002. 50 pages. Advisor: Greg Newby

This paper will describe my development of Aims Online Testing System, an interactive web-based testing mechanism which was established as a pilot project as well as a learning and evaluation tool, using Microsoft SQL Server 7.0, ColdFusion, JavaScript and Visual Basic for the School of Medicine, UNC Chapel Hill. An explanation of the process followed to create this product, information of the software used, description of the final design, analysis of risks and constrains as well as envision of the future work constitute the main body of the paper. At the end, user guides are appended to indicate how an online exam is implemented. As a pilot project, although the final success will not be known until it used in classroom in the future, this technical report has immediate importance because it documents the creation and implementation of the web-based testing system.

Headings:

Web-based testing

Computer-based testing

Online testing

AIMS ONLINE TESTING SYSTEM, AN INTERACTIVE WEB-BASED TESTING
SYSTEM FOR MEDICAL SCHOOL COURSES

By
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Chapter 1:Introduction

The goal of this project was to pilot an online testing system, which will serve the courses at School of Medicine, UNC Chapel Hill, as a learning facility and an examination tool by imitating United States Medical Licensing Examination (USMLE) testing environment. The design and implementation of this new system was based on the existing AIMS System. And in order to carry on an online examination, the new system must work together with the current AIMS. I started working on this project since the last summer, May 2001. Whether the product will be applied to real classroom examination in the 2002 fall semester, depends on the school's budget condition.

1.1 Background and Rational

The Office of Education Development, at the school of Medicine, UNC at Chapel Hill built Assessment and Item Management System (AIMS), a test development, management and assessment system several years ago. AIMS resides on Windows-NT platform and uses Access97 to house its test question bank. With a Visual Basic interface, course directors can access, modify, delete, review previous or create, design and edit new questions and tests, as well as grade and report exams. Primarily, the current AIMS benefits faculties by helping them create effective and objective questions as well as automating grading. As for students, they still need to take paper and pencil test. While Computer-Based Test (CBT) is emerging and getting increasingly predominant in the

medical education field, the school's current traditional testing system can't keep pace with the new trend.

Medical students are required to pass The United States Medical Licensing Examination (USMLE) to further their doctor careers after graduations. Since the year 2001, this examination has successfully shifted to the computerized. Students need to take the exam within a computer-based environment in a chosen test center. Different from the traditional paper test, the CBT environment calls for the prior experience and familiarization with the testing environment ahead of the actual test. While the computer-based examination is becoming popular in medical area, the school remains minimum in practice at this point. Thus, they call for a new learning and examination tool to help students adapt to the CBT environment and achieve test-taking skills in advance. Some commercial products could be found on market, which might be used for the practice purpose while not suitable for real classroom examination. Furthermore, they are costly for both students and the school. As the school asks all of the new enrolled students to buy laptops, the OED office was determined to develop a computer-based testing system on the basis of students' laptops.

1.2 Literature Review

In the face of rapid growth of computer based testing, a lot of research has been done in this area.

Computer-based tests are defined as tests or assessments that are administered by computer in either stand-alone or networked configuration or by other technology devices linked to the Internet or the World Wide Web. The Association of Test Publishers (ATP) published recent Guidelines for Computer-Based Testing in February 2000. According to the guideline, “all computer-based tests should be designed by using the fundamental standards identified in the six technical areas for 1) test construction, evaluation, and documentation; 2) reliability and errors of measurement; 3) test development, and revision; 4) scales, norms, and score comparability; 5) test administration, scoring, and reporting; and 6) supporting documentation for tests. The committee also recommended that all computer-based tests be used in accordance with fundamental measurement standards for test fairness, including fairness in testing and test use, in the rights and responsibilities of test takers, in testing individuals with diverse linguistic backgrounds, and in testing individuals with disabilities. “(By James B. Olsen, Guidelines for Computer-Based Testing). Although the evaluation of the success of a testing application should depend on professional judgment, the “Standards” covers broad relevant issues, which was quite instructive and helpful in the process of my development.

As it was determined to be a web-database project in the very beginning, I limited my research and attention to the web-based testing studies. I found an ever-increasing amount of "courseware" is appearing on the Web. Some of them are open resources while some others are commercial products. Without effective security and authentication mechanism, most of them can only be used for distance education, subjective tests, or tutorial and practice purpose but not competent for a formal classroom examination. Out

of them, a commercial product called *eZ.exam* Online Assessment Software developed by NCS Pearson is a very good assessment and administration tool. However, it uses general Internet Browser as front-in environment, which will certainly cause security leakage. This drawback downsizes its value and appropriateness in serious classroom examinations.

I couldn't find any evidence that any CBT system fitting in our criteria and gauge has ever been done on the web. Most documentation focus on standards and evaluation of a web-based system but rarely talk about creation process.

Chapter 2: User Scenarios

The current AIMS only serves and is accessible by the class directors and the test coordinator. By contrast, the new AIMS Online will have two more user groups other than current users. And each user group has respective demands:

- Students: the medical students who are eligible to take a particular test. They are supposed to be on a class roster and their information should be in the database ahead of any online exam. Students expect a friendly, easy-to-use and reliable system, which would be better similar to USMLE examination.
- AIMS coordinator: She is responsible for administering all of the future online exams. She's not a technical person and hectic with a lot of daily work. So complexity and workload top her concerns. She anticipates still working in a familiar environment without adding extra workload and will not take her too much time to adapt to.
- Proctors: Generally but not necessarily, they are class directors who are on site to oversee the test taking process. In addition to class directors, any executive staff at the school may take a substitute upon teaching faculties' request. Proctors expect a functional mechanism, which effectively keeps students from plagiarism so that online examinations are reliable and fair. At this point, security of the system is their biggest concern.

- Class directors: Class directors are not direct users of the online testing system if they are not proctors. Class directors still need to work on the current AIMS to design questions and tests, as well as grading.

Chapter 3: System Scenario

3.1 Current Aims system

The current AIMS is multi-faced, networkable, test development and test management system, with a Visual Basic interface to a Microsoft Access database. AIMS provides secure access to exam information for course directors and their designees. AIMS facilitates the review of test items across courses and content areas. Currently, there are about 10000 test questions and 200 tests in the Access97 database. Tests, questions as well as student and faculty profiles are stored into 20 tables based on their relations.

To use AIMS, teaching faculties first need to develop student exams, write and modify all questions and answers used in these exams through the Visual Basic Interface. Afterwards, the course directors tell the AIMS coordinator the ID numbers of their tests. According to the ID numbers, the AIMS coordinator modifies and checks the layout of tests then notifies Medical Sciences Teaching Labs (MSTL) office, who is responsible for copying and distributing the exams and Scranton sheets prior to the scheduled time of the exam. Once the exam is over, the AIMS Coordinator will scan the Scranton exam sheets. When scanning is complete, a text file containing student answers is generated. The coordinator imports the text file to AIMS Access database table then the exam is ready to be scored by VB code. At last, the AIMS Coordinator will prepare the exam statistics report.

3.2 Facility settings

An ideal examination environment should be built as a test center, such as the GRE or USMLS test, which is a dedicated computer lab equipped with dedicated local area network, pre-cleaned and pre-configured desktops or dummy terminals, pre-registered test takers and photo-ID check -in authentication, as well as cameras to monitor the whole process. However, none of above is available or applicable in the School of Medicine.

First of all the school can't provide a computer lab for the new computer based examination. A regular class size is 100-200 students. However, the school 's computer lab only has 40-50 laptops. Moreover, due to the space shortage, they can't find any other place where can accommodate more than 100 students expect classrooms. Secondly, there are no terminals and dedicated server available. Students' personal laptops would be the only possible basis of the future examinations under the current circumstance.

Other possible facility support may be accessible from the technical support department of the medical school, which has Microsoft SQL server 7.0, cold fusion server and web server in place. OED can ask their permission and help to share those space and facilities. With the success of the pilot project, OED is proposing a budget plan to purchase its own server and other supplies for the new system setup.

3.3 Project Criteria

Given the current hardware settings, features of existing AIMS System as well as custom user needs, the OED office set the essential criteria for the project, which provided direction for principles and procedures of my development.

First of all, security is the most critical issue for the online testing system. It includes the following aspects:

- User authentication;
- Reduce likelihood of any form of cheating such as using external material;
- Restrict availability of test by date/time;
- Students can't save local copy of the test questions on their laptops during or after any online test;
- Time exams. The testing environment must have timing mechanism to automatically control the test time.

In addition to security, performance is another key that determines the success of the system. With hundreds laptops squeezing into the medical schools' network simultaneously during online examination, the traffic on the network is supposed to get aggravated tremendously. Moreover, good chances are that examinations often take place at peak time of a day, which makes the situations worse. As far as a timed examination is concerned, the new system should avoid or reduce networking delay and data loss as much as possible while data is transmitted across networks.

Following those criteria, Microsoft SQL Server 7.0 was chosen to be the backend database. Cold Fusion and JavaScript will be used to develop the student web front-in interface while Visual Basic becomes the developing tools for the Administrator Interface.

Chapter 4: Design of Online Testing System

4.1 Web-database solution

Computer-based testing doesn't have to go onto the Internet. As a matter of fact, to build a secure and robust test environment, the Internet would be the last choice. As I discussed in Chapter 3, an ideal test environment should be a dedicated test center, such as the GRE test. Unfortunately, it's not applicable and feasible to the school. Based on the facility limitations and tight budget, Internet seems the only choice left. Thus, the web-database solution was determined for building the online portion of AIMS in the very beginning of the development.

4.2 Workflow Of New AIMS Online Testing System

Developing a brand new system from the scratch is time consuming and inefficient in our case. Moreover, even if in the near future when the pilot project are approved to put into real use in classroom, the paper tests will still stay for some period of time. In order to have the system work in both paper and online testing environment, reduce the complexity and redundancy of development, simplify administration and training procedures, the Online Testing System was decided to become one component of current AIMS instead of a stand-alone or independent system.

At the beginning of design phase, Microsoft SQL Server was chosen as the backend database for the Online Testing. Migrating data from Access to SQL Server is such a pain and the Visual Basic code has to be changed correspondingly. To avoid this nuisance, I decided to only have the SQL server house given online test (tests) but not the entire test question bank and student profiles. In this way, the teaching faculties can still remain their work procedure, namely to develop a test on the current AIMS side and tell the coordinator test number. At this point, the teaching faculties (test designees) don't even feel the change of the system. The current Visual Basic code will remain intact. However, to implement an online test, inevitably, the AIMS coordinator has to carry out more workload other than procedures she's doing on current AIMS. After being notified of the particular online test number and having the test saved in Access database, the coordinator needs to load the test questions and test takers' profiles from Access database to SQL Server. And when the test is over, the coordinator must export the students' answers to a text file. Afterwards, all her work left is to load the file back to AIMS, score the test and do reports, as what she does with current AIMS. Figure 4 illustrates the workflow between the Access and SQL server side (See figure 4.1).

As the figure shows, data transformation between AIMS Access database and SQL Server online is a key of the project. Administrator Interface was developed to facilitate this task as well as online test administration.

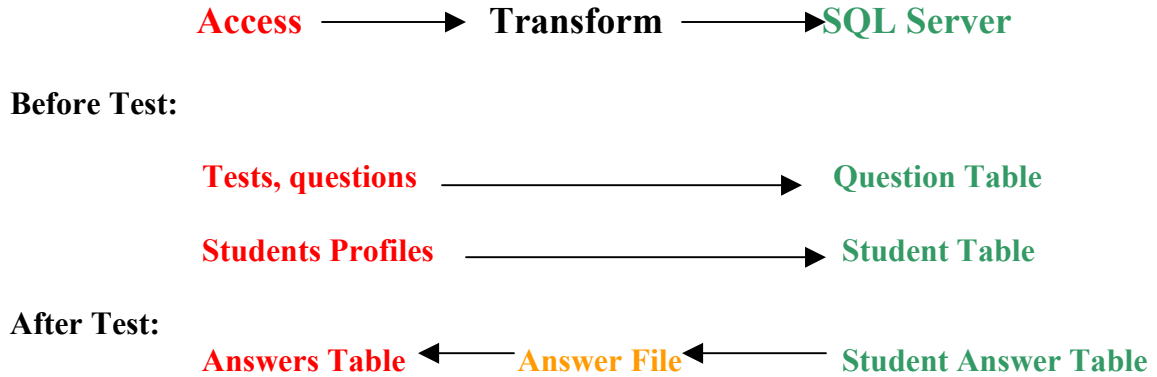


Figure 4.1: The workflow of AIMS Online Portion. Test, questions and student profiles in Access (on the left hand of the figure) are transformed to the equivalent table on the SQL server (right hand of the figure) before a given online test. Students' answers are exported from SQL server to a text file then import to Access answer table.

4.3 Administration Interface

In order to keep consistence with the current AIMS administration interface, I decided to use Visual Basic to code the Online Testing Administration Interface. Two forms "Data Transformation" and "Test administration" (see figure 4.2, figure 4.3) were created to assist the AIMS coordinator accomplish essential tasks needed for an online test. My idea about this interface is to keep it as simple as possible. It will be only used for the sake of data transition, and online test administration. Although AIMS Online is one portion of AIMS utility, its administration interface wasn't knot into current AIMS interface. The reason for this is simply that current AIMS is frequently used on a daily basis while AIMS Online is subject to change. In Chapter 7, Administration Guide is presented to illustrate how to use those forms.

Select a test you want to use:

Test No.	Title	Course	Term
161	Test of New England Culture	Administrative	F
193	Test of Quasi-Medical Knowledge	Administrative	S
203	Nuts and Bolts: Self Assessment, 2002	Administrative	S
204	Test of Special Sumbols and Fonts	Administrative	X
157	Biochemical Foundations of Medicine: Fir...	Biochemistry	F
164	Biochemical Foundations of Medicine: Mi...	Biochemistry	F
181	Biochemical Foundations of Medicine: Fin...	Biochemistry	F
1	Cardiovascular System: Final Exam, 9/26/97	Cardiovascular Sy...	F
10	Cardiovascular System: Final Exam, 9/25/98	Cardiovascular Sy...	F
62	Cardiovascular Svsstem: Final Exam. 9/8/99	Cardiovascular Sv...	F

Enter Test Password

Figure 4.2: Data Transformation Form.

Select An Online Test:

Online Test	Aims Test
161	161
184	184
204gb2	204

Description
This is a test of your knowledge about some very esoteric and quasi-medical content areas. You have 20 minutes to complete this exam. Partial credit will not be given for any

Title
Test of Medical Trivia

Test Schedule

Start From
5/3/2002 9:00:00 AM
Sample: 6/7/02 1:30:00 or 6/7/02 1:00 PM

End At
5/3/2002 5:00:00 PM

Test Duration:
20 Minutes

Re_login Password:
relogin184

Figure 4.3: Test Administration Form

4.4 Stored Procedure and DTS Packages

As I mentioned above, when implementing online testing, we just want to upload the given test (tests) to SQL server instead of the entire test question bank. In that case we

need to have three tables for each given online test on SQL server side, which are “testquestions” table, “students” table and “answers” table. Manually creating these tables is tedious and problematic. A better solution would be creating tables at runtime when the coordinator chooses a test for online testing. In addition to creating tables, data transformation between Access and SQL Server as well as SQL Server and a flat file are needed for the AIMS coordinator to carry on online examinations.

Visual Basic provides programmers with plentiful APIs to operate a database as well as data transformation. However, to have a custom program which meets with our special transformation needs is not trivia with VB coding, especially under the circumstance that I had no much Visual Basic programming experience prior to the project. Fortunately, SQL server comes to rescue. Microsoft SQL Server comes with DTS (Data Transformation Service) Component, which is dedicated to support transforming data between SQL server and any other Microsoft OLE or Oracle Database, or even a flat file. And “Stored Procedures” can be used to create tables with input parameters at runtime. Although I still need to do some coding to make the data transformation more flexible and generic, ActiveX scripting in DTS Designer or T-SQL scripting for Stored Procedure is much easier than Visual Basic for me. Furthermore, both DTS package and stored procedures are located on SQL server side, as far as the performance and security is concerned, it’s faster and more secure than client side Visual Basic.

I first created a stored procedure called “Sp_PrepareTables” to create tables at application runtime. Once tables are created, it’s ready to transform data. For this purpose, I created

two DTS packages, out of which “UploadToSQL” is meant to import test questions and students profiles from Access to SQL Server according to input parameters. The stored procedures “Sp_PrepareTables” and “UploadToSQL” are called in order once the coordinator chooses a test and click the “Upload” button (See Figure 4.2). The other DTS package “DownloadAnswers” is used to export students’ answers to a text file according to input parameters “filename” and “testnumber”. It ‘s called when the coordinator clicks “Export Answers “ button.

All the work I described so far is only the backend utilities at online examinations preparing phase. It has nothing to do with the front-in test environment yet. The following sessions are about to discuss and introduce the front-in interface used by students while taking online tests.

4.5 Front-in Web Browser: Secure Browser

Given the condition that our CBT examinations will go online to the Internet, a web browser is required. Apparently, the regular Internet browser such as Explorer and Netscape can’t meet with our security criteria. After research and searching, we found a commercial product called Secure Browser, which may improve the security of testing environment a great deal. The Secure Browser uses IE to host the browser itself under a protective and much more restrictive shell. The security features of the secure browser are:

- Password needed for entering and modifying settings;
- Password for opening/closing Secure Browser;

- Ability to lock workstation so other programs can't run except Secure Browser;
- Full screen restricted mode;
- Restricted web access to specified sites only;
- Restrict other Browsers as well to specified keywords and sites only;

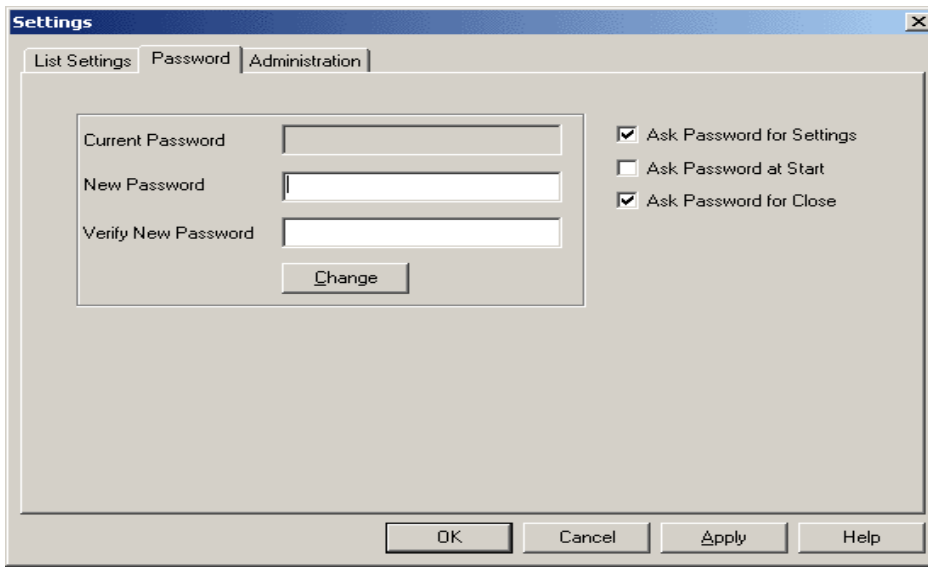


Figure 4.4: Secure Browser Password Setting

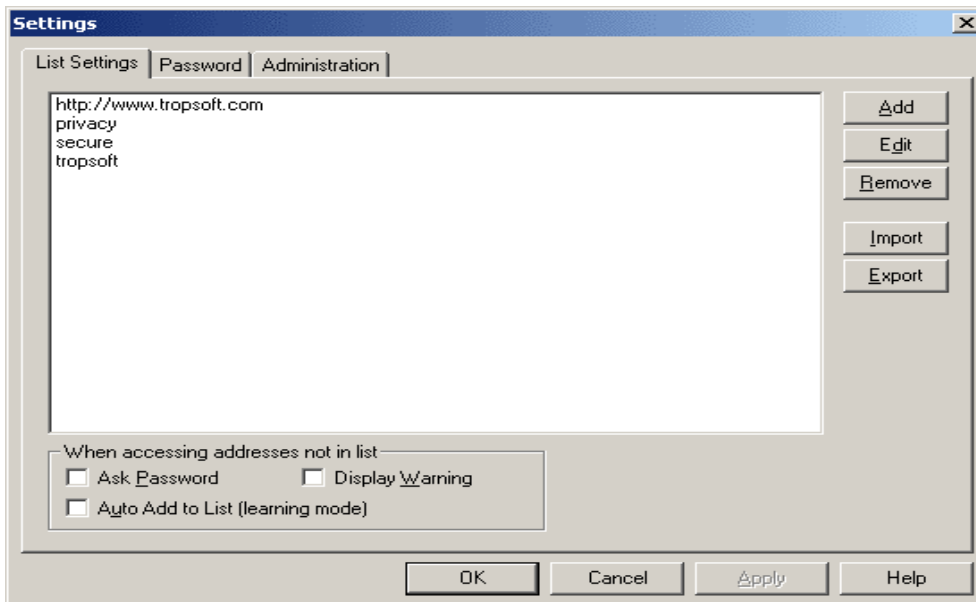


Figure 4.5: Secure Browser Custom List Settings to restrict websites

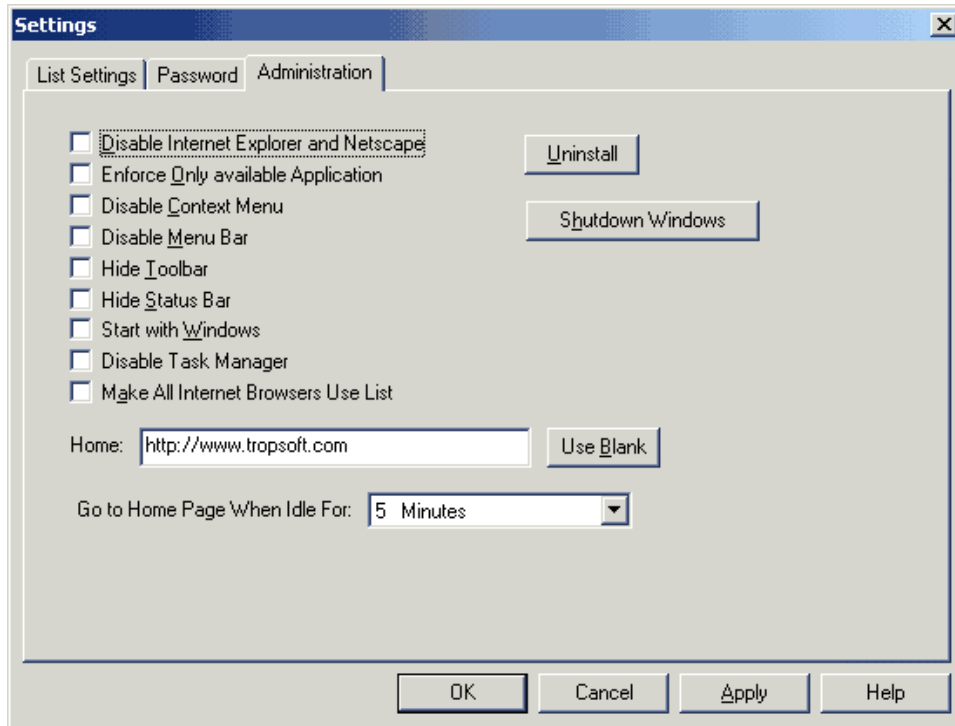


Figure 4.6: Secure Browser Administration Setting

It turns out the installation and un-installation processes are quite simple. And the price to have its site license is affordable. Thus, we managed to use the Secure Browser as the interface for students to take our online examinations.

4.6 Mirroring USMLE User Interface

The one important goal of the project is to help students adapt to USMLE testing environment and get hands-on experience in prior. As a result, the student interface design was referred to USMLE interface. Generally speaking, USMLE interface provides with these functionalities: Questions Navigation, Timer Control and Answer Item Review.

Block 1: Item 7 of 50

Mark Time Remaining: 59:54

An inexpensive screening test for a disease is available through analysis of venous blood. The distributions of blood concentrations for persons with and without the disease are depicted in the graph. The disease is irreversible and fatal if not discovered and treated early. What letter represents the most appropriate cutoff point between normal and abnormal?

A. B. C. D. E.

Normal Labs

Select the best answer.

Next Previous Item Review Help

Figure 4.7: Prototype of USMLE Test Questions Page

Block 1: Item Review Time Remaining: 56:30

50 Items

1. C	23. A	45. E
2. A	24. E	46. A
3. E	25. D	47. A
4. E	26. A	48. D
5. B	27. B	49. E
6. B	28. E	50. E
7. A	29. A	
8. E	30. A	Block 1 Answer Key
9. E	31. D	
10. A	32. D	
11. D	33. A	
12. C	34. B	
13. D	35. D	
14. E	36. A	
15. A	37. A	
16. D	38. A	
17. E	39. B	
18. E	40. D	
19. D	41. A	
20. B	42. B	
21. H	43. C	
22. B	44. E	

M = Marked Items Review Item 41

Review Marked End Help

Figure 4.8: Prototype of USMLE item review page:

By studying the USMLE prototypes, I built a similar question navigation system and user interface with ColdFusion and Javascript for AIMS Online.

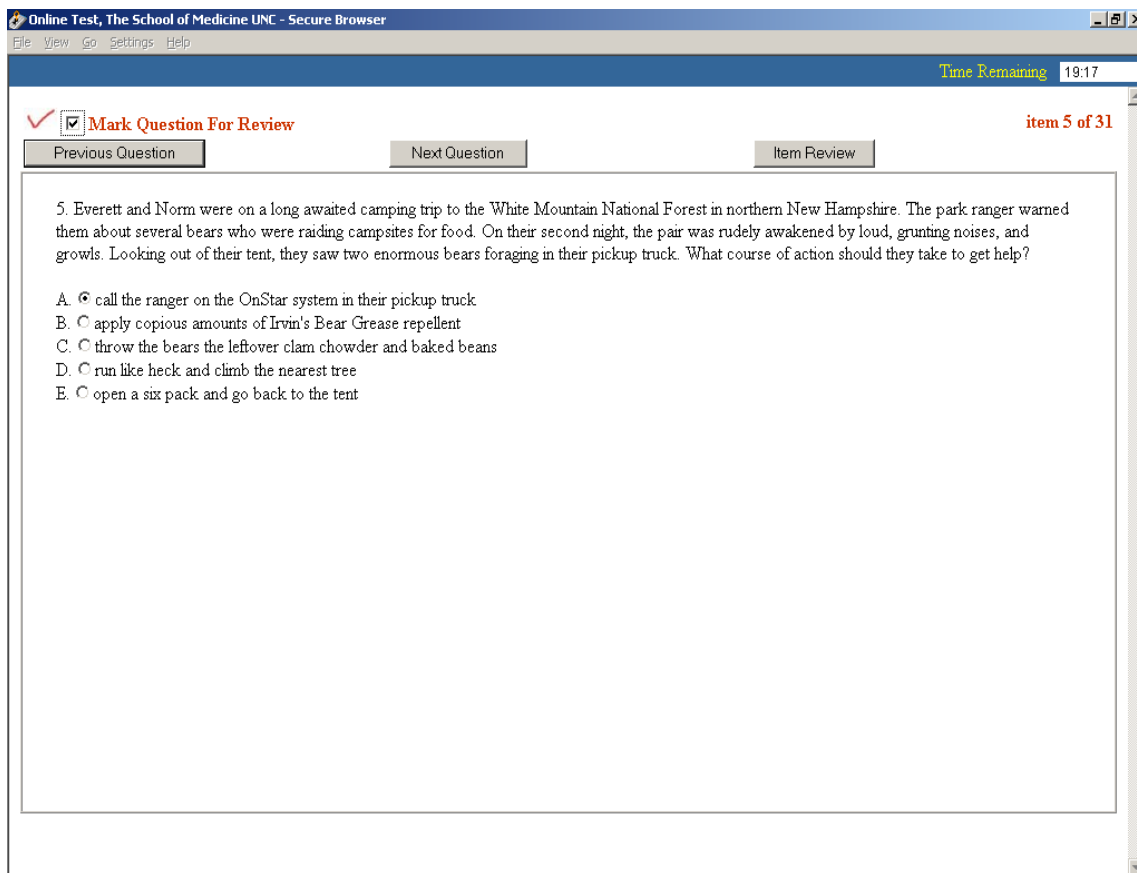


Figure 4.9: Prototype of AIMS Online Question Page

As we can see from the figures, AIMS online testing interface inherits the most features of USMLE examination, for instance

- One question per page;
- A clock on the rightmost corner reminds the time remaining;
- “Next question” and “Previous question” buttons guide students navigate through all the questions;

- “Item Review” presents all the answers and each link refers back to a given question;
- A check box “Mark” is located on the left corner of each question page. Once a question is marked, on review page, a yellow “M” will show up beside the question.
- Answered and unanswered questions are differentiated on “ Item Review” page;
- Confirmation page is coming up when student click ‘exit ‘ button.

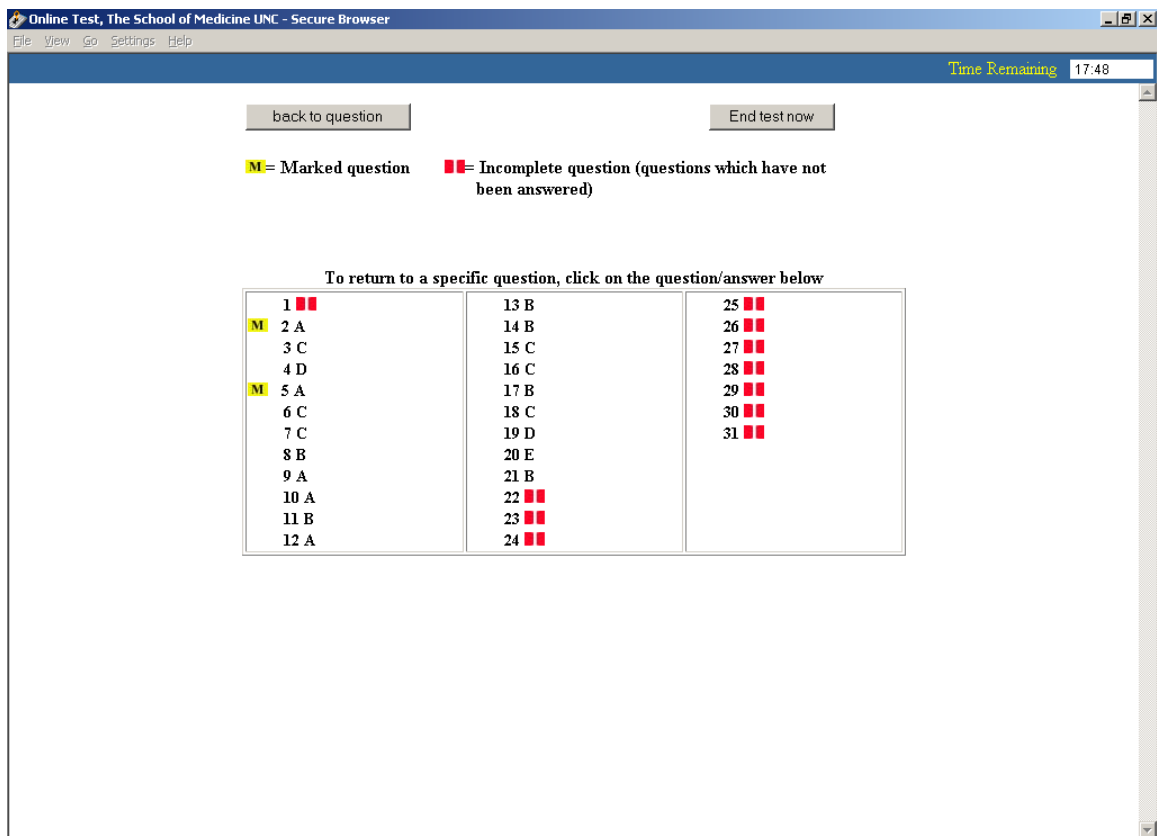


Figure 4.10: Prototype of AIMS Online Item Review Page

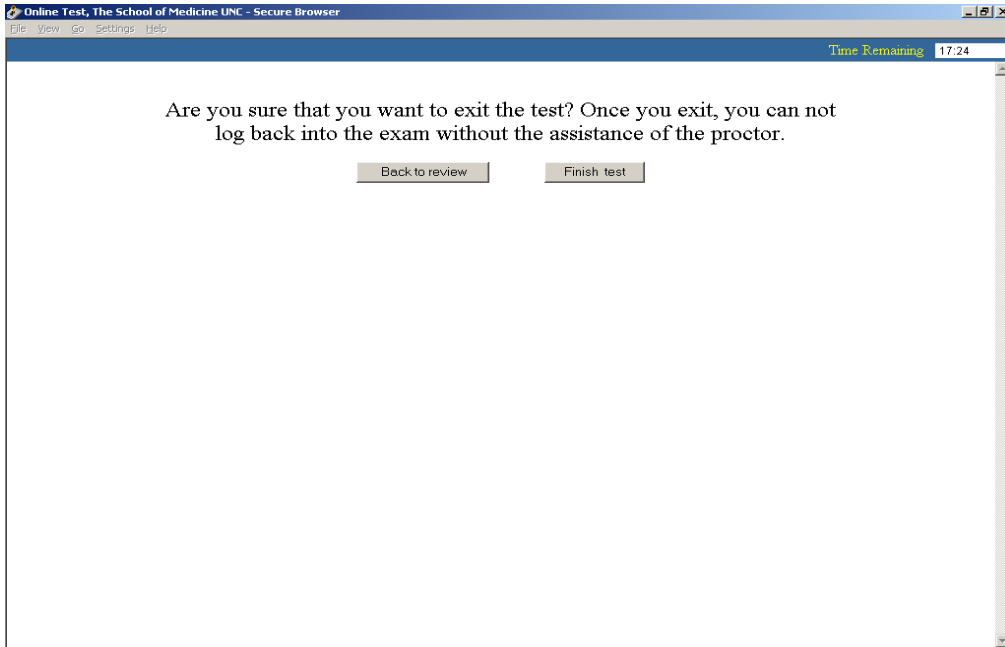


Figure 4.11: AIMS Online Exit Confirmation Page

While input major features of USMLE interface, according to our own database structure, patterns of test questions and customized user needs, I also made some adjustments and changes on our own AIMS online testing interface.

- Image is on the top of any question text instead of bottom.
- Different font color is used to distinguish the first narrative text from later narrative questions. (A narrative question is a series of questions associated with the same scenario.) For the current paper test, the narrative text only appears at the first question.

4.7 Security Mechanism

Although I could imitate USMLE test interface, given the current testing facilities at the school, to make a secure CBT environment with the same high-level standard, as

USMLE is almost impossible. I had to do user authentication, test time control and cheating precautions by ColdFusion and Javascript code. Both client side and server side checking were used to meet with our specific security gauge:

- Double password checking for test and user authentication. The test number is created as a test password by the AIMS coordinator at runtime and stored into “testinfo” table on SQL Server (see figure 4.12). This password will be only distributed and announced in classroom when an online examination starts. In order to take an online test, students have to be on site to get the test number. Furthermore, with the test number, multiple online examinations can be held concurrently. Student PID number is used as the student login password (see figure 4.13). After enter PID number, a confirmation page will bring up the student’s profile from database. The student must confirm his information to start the exam.
- If students not login from the test login page, they will be forced to go back to the very first page. Thus, even they click the test questions page in the browser’s histories they will still be led back to the first login page. With this restriction, students will never see test questions again once they leave or exit the test.
- Students will only have three chances to try their passwords or test numbers. After three times, the session will end. They have to close the window and start over.
- Client side test timer: Once the timer started, it will keep ticking until the scheduled test time is up. By then, an alert message box will pop out and direct the student exit the test. This timer is code with Javascript.

- Server side time checking: Students can and only can access a given online test during scheduled test time. This is implemented by comparing the system time to the scheduled test time stored on SQL server database when students login. (See figure 4.15)
- Disable “ Alt+ ←” combination keys. Although the Secure Browser can hide menu bar so “back “ and “ forward ” buttons are invisible for students, the combination keys can serve the same functions as the “forward” and “back” icons. Because the Client side timer is used to control the test time, once the “back” function called, the page in history will bring back the previous page ‘s time, which will cause fatal mistake. To avoid this phenomenon, a piece of JavaScript code on each of page is used to forces the page go backward or forward. By this way, students will always stay on the same page unless they use navigation button to move on.
- Re-login password. There might be some unexpected situations occur, such as network congestions cause pages lost, or students close the Secure Browser abruptly. The system will record the last login time and save it in a table. So, even if this kind of problems occurs, when the student input his password, the system will detect he already logged in and give out the last login time, then ask for the re-login password, which is hidden from test takers, while known by the proctor. To continue the exam, the student must contact the proctor. According to his last login time, the proctor determines the rest time. This solution is not perfectly accurate in terms of test time, however it’s the only way I could think of

to get around this problem given the fact that the Internet is stateless. (See figure 4.16)

- Once students finish an online test and click “exit” button, they can’t go back to the test questions by any means. It is implemented by laying a variable in SQL server table as a flag. Before students can login to tests, the system will check on the flag to determine if the student is still legitimated to login.

In addition to the security restrictions above, network mirror software will be used in the future once the project put into real use. By then, all the traffic out from test takers’ laptops will be recorded. This may prevent students from sending and receiving emails or any other cheating behaviors across network.

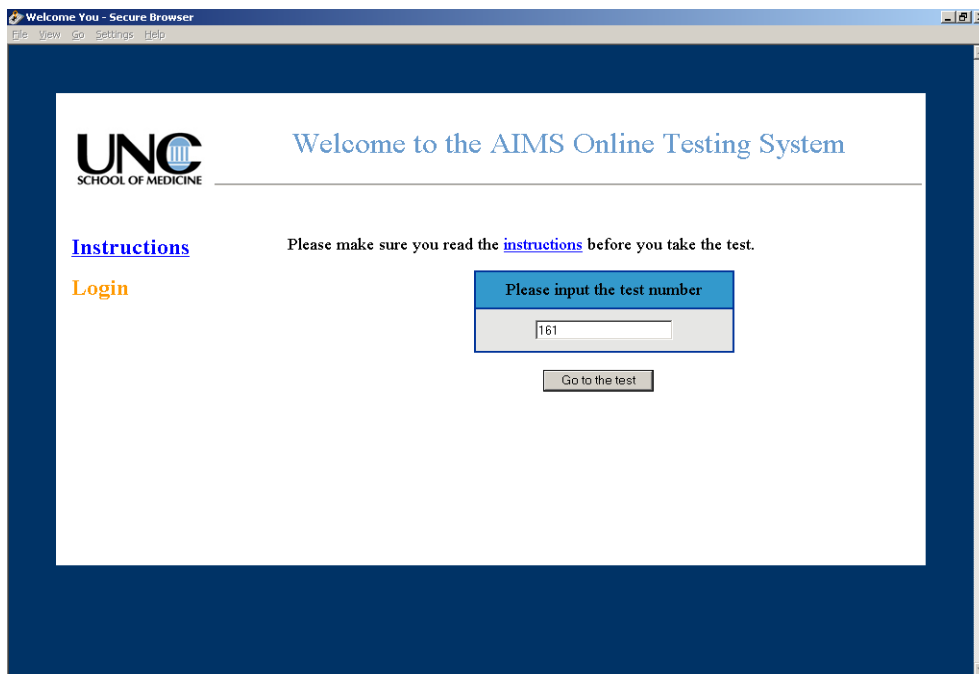



Figure 4.12: The Front Page of AIMS Online. Students must enter a test number to start taking the test.



Student Login - Secure Browser

UNC SCHOOL OF MEDICINE

Welcome To The Aims Online Testing System

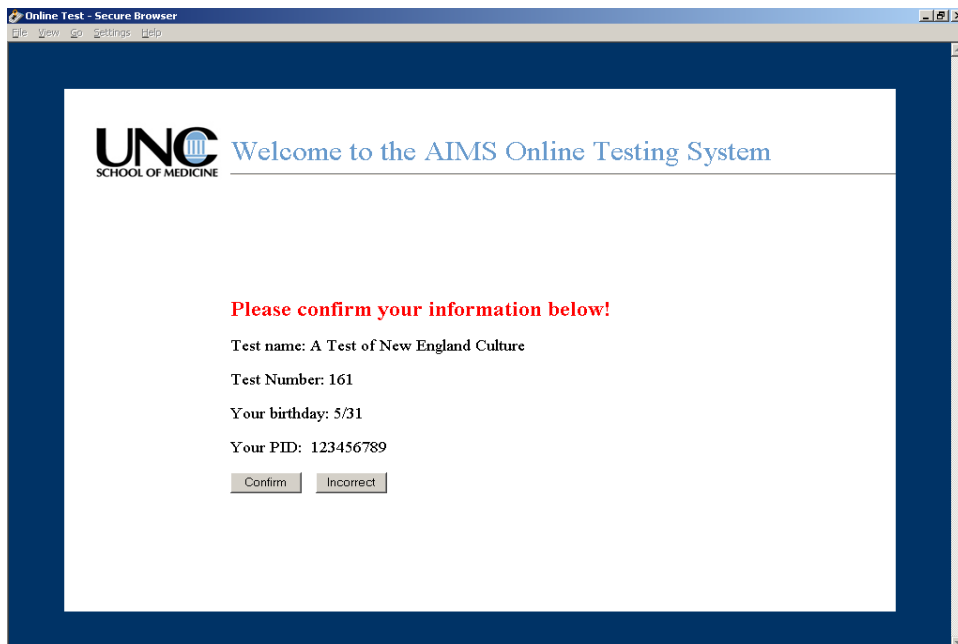
Please input your PID number

Please log in

Password

Log in

Figure 4.13: Student Login Page. Students need to enter their PID.



Online Test - Secure Browser

UNC SCHOOL OF MEDICINE

Welcome to the AIMS Online Testing System

Please confirm your information below!

Test name: A Test of New England Culture

Test Number: 161

Your birthday: 5/31

Your PID: 123456789

Confirm Incorrect

Figure 4.14: AIMS Online Student Profile Confirmation Page

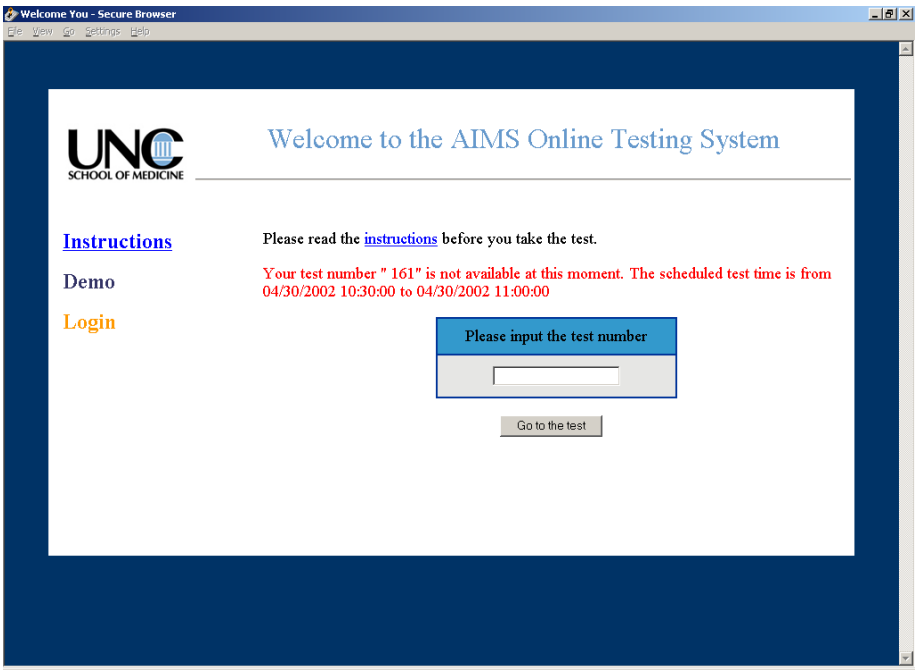


Figure 4.15 shows student can only access an online test within a legitimated time range.

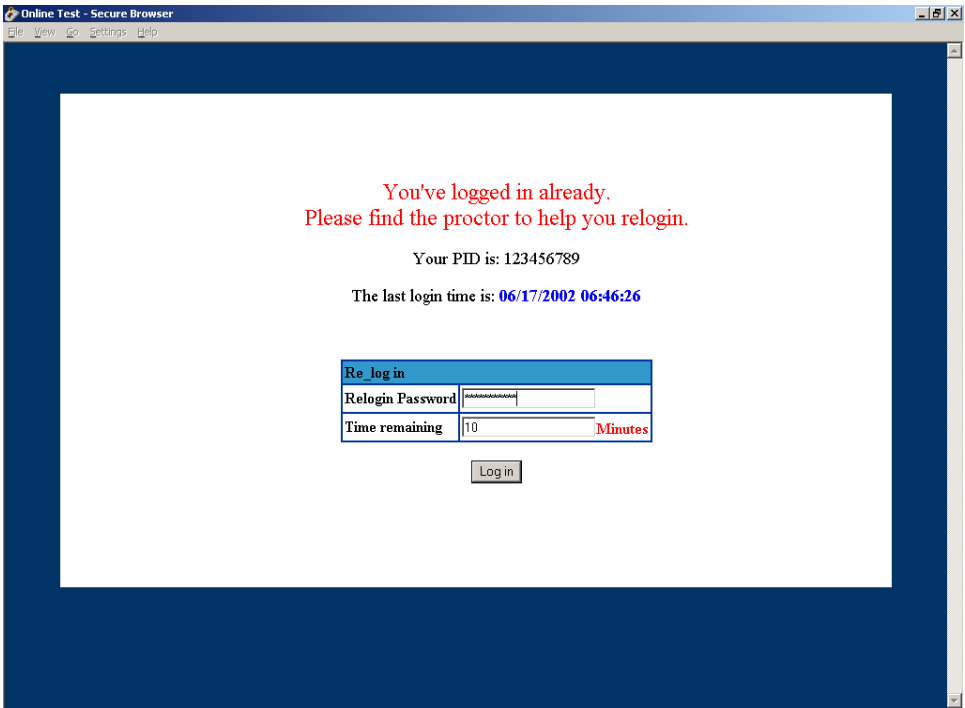


Figure 4.16: Aims Online Re-login Page. Only proctors have the information required by this page. Thus, students must go to ask a proctor and the proctor fill out the form so that the student can go back to the test.

Chapter 5: Testing and Evaluation

After more than half a year's design and development, the AIMS Online Testing System was established. The next task was moved on to the project testing and evaluation. Given the fact that administration interface was easy to evaluate and test, we focused our testing and evaluation on performance of web interface and security restrictions.

So far three beta tests have been held. Out of them, the first two were carried out in OED office with the Secure Browser installed and configured on the office's desktops. The first test was meant to collect opinions toward user interface design. 15 OED staffs attended the experiment. The second test was meant to examine the security functionalities as well as the opinions toward modified user interface. The test location was still in OED main offices. 20 OED staffs including 2 technical staffs from the school's technical support department divided into 2 groups took two online tests simultaneously. No formal survey questions were given in either test while test takers were asked to write down their opinions and thoughts at will. From the feedback, most staffs were satisfied with the security feature of the system but came up with different thoughts of user interface. Changes were made based on the feedbacks. The third beta test was held much more formal compared to the first two. It was held in medical school's computer lab. 20 students, 1 teaching faculty and 3 OED staffs were invited to take two concurrent tests with lab's laptops. Ahead of the test, 15 survey questions were designed

and answered by test takers afterwards. Overall, the attitude towards the system was positive while test takers also pointed out some flaw in the system. Appendix C shows the students' feedbacks in details.

After the three beta tests, the student interface was acknowledged to be applicable and feasible. It may not need major change in the future.

Chapter 6: Constrains and Future Work

6.1 Constrains and Risks:

Through the user feedbacks from three beta tests as well as the beta tests themselves, constrains and risks were identified too, which may not be overcome under the current design and facilities.

First of all, there are obvious downsides using the Secure Browser while it can meet with most of project requirements. First of all, the secure browser must be installed on every student's laptop at the beginning of each semester. That's not a trivial work. Moreover, during the semester, the students may uninstall the secure browser by accident or on purpose, which may bring up more work. Second of all, there is no way to differentiate the Secure Browser from regular Internet Explorer, which means the server will not know whom it is talking to. For the purpose of this project, ideally the Secure Browser should be the one and the only one allowed to use. Because the system is incapable of stopping students from using other browsers by itself, proctors have to keep a close eye on every student to ensure "Secure Browser" is the one being used. On one hand, it's not an effective way to prevent students from cheating. On the other hand, it raises proctor's burden.

Second of all, there is a chance that the ColdFusion pages may get lost during an online examination due to networking jam. In that case, students have to ask a proctor to log them back into the test. The proctor will assign the rest of time for students based on their last login time. But if the network jam cause the whole class loses contact to the server, the proctor has to process the same procedure manually for each student. This may take a while. As a result, the accuracy of test time would vary from student to student, which will hurt the objectiveness and fairness of the online examination.

6.2 Future work suggested

To get around and overcome the limitation of the Secure Browser, it would be better to code a customized interface (something like Secure Browser) for students. In that case, it's able to add a user agent string into the application so that the server-side would know whom it's talking to. Either Visual Basic or Java is a good choice to code the graphic interface.

Although it's impossible in the present, a dedicated test center is strongly recommended as far as a secure, reliable and quality-testing environment is concerned.

This system would be more interactive and useful if multimedia contents could be incorporated. In that case, live diagnosis could be done and counted as one part of test assessment. Some students and teaching faculties already presented their interest and demand toward the application of multimedia in CBT.

In order for system integrity and easy maintenance, AIMS Online Testing Administration Interface should be tied with the current AIMS in the future.

Chapter 7: User Guides

7.1 Administrator Guide

Before using the administrator interface to apply an online test, the test must have been developed and revised with the current AIMS system.

1. Load Tests and students profiles to SQL server

Open the Aims Online Testing Administrator interface, select a test you wan to apply from the list view of tests; input a test password which will be used as test authentication number; Then click “Upload” button. It may take a couple minutes to upload data from Access to SQL Server. After loading is complete, a message box will pop out, click “OK”.

If an online test already exists on SQL server, its tables will be overridden once you click “Upload” button.

2. Schedule an Online Test.

Open “Test Administration” form and select your online test from the list view of tests. All tests appear in here are only those saved on the SQL Server. Once you click a test item in the list view, test title and description, data of starting and ending time, as well as re-login password (used when students exit and back to a given online test), associated

with the test, will show up in their respective field. You can modify those fields at your will. When you enter date and time for either “start from” or “end at” field, be careful of the data format. Refer to the sample format marked on the form. Generally, you can enter any type of legitimated “datetime” format. If your date and time entered is not valid, error handling will tell you where goes wrong. After filling out the form, click “Save” button to save your result onto the SQL Server.

3. Export student answer to a text file

Still Open “Test Administration” form. Select a source online test and then click “Export Answers” button. It will lead you to your locale file system. Choose a target directory and file then save it. Afterwards, you can directly load the file into the Access table by using current AIMS system.

4. Delete an Online Test:

Open “Test Administration” Form, select an online test then click “Delete “ button. Once you click this button, questions, students, and answers tied with the test you selected will be wiped out from the SQL Server. This function is somewhat problematic and risky in terms of answers table on the SQL Server. Because it is the only place where students’ answers are alive. Once you click the button by accident, you’ll lose all the answers. The loss may make the finished test in vain. In order to get around this, when you click delete button, a local copy of data in the answer table will be automatically saved on your C: drive in case you still need them. The file name is defaulted to “yourtestnumber.backup”. If you do mean to wipe out student answers completely, you can further delete the file

from your C drive. As for test questions and student profile data, no local copies are going to be saved if you click “delete” because you can easily retrieve those data from tables on Access side.

7.2 Student Guide:

1. Software Installation

Before you use the AIMS Online Testing System, you must install the Secure Browser with the assistance of OED staff. Without using Secure Browser taking online tests will be treated as plagiarism and your score will be nullified. Once installed on your computer, an icon marked “Secure Browser” will appear on your desktop. Just click it and you will be led to the log in page.

2. Obtaining Access to exams.

The exams will be active only within the range of scheduled test time. Once out of the range, you will not be able to access the exams.

You need the following steps to login to an online exam.

- 1) Enter your test number. You will be asked to input your test number by the front page. You can only get this number right before a given online test from your proctor. The proctor may write it down on blackboard of your classroom up to then.
- 2) Honor code. After choosing a test, the online test honor code page will be brought up to you. You must click “agree” button to accept the honor code and proceed.

- 3) Login to the exam with your PID number.
- 4) Verify your information. As part of the secure login process, we will ask you to verify your identity by first name and birthday. If the information correct, press confirm to continue.
- 5) Start the test. After your confirmation, a test information page will tell you the name of the exam, the time you allowed to take the test as well as some specific instructions to take the test. You need to press “start” button to proceed. Once start a test, the timer will keep ticking until time is out.

3. During exams

- 1) Navigate test questions with “Previous question” and “Next question” button.
- 2) Mark the question you ‘d like to remember for later reconsidering. Select the check box in the upper rightmost corner.
- 3) View your answers and navigate to a question through review page. You can press “Review “ button at any time during the test. The review page will return all your answers, out of which marked questions have a yellow “M” next to them. You can click any answer to lead you back to that question.

4. Exit exams

Within the test time, you can exit the exam any time by clicking the “Exit” button on the “review” page. The next confirmation page will give you another chance to stay or leave. Once confirmed your leaving, you completely finish and exit the exam. You are not allowed to come back the exam by any means.

When time's up, a warning message will pop up telling you your time is expired. Even if you haven't finished the test, the test will end after this message.

5. Restrictions:

During the test, please don't click "X" button in the rightmost corner of the browser. If you do so, the test will be ended unexpectedly and some of your data may get lost. You are not able to log back in without a proctor's help. Please close the window only when the instruction tells you it's safe to do so.

7.3 Proctor Guide:

1. Before test:

Before each online exam, the proctor should have these documents: a list of student names, the exam number, the test re-login password, the test schedule, all of which are varied from exams to exams.

- 1) Write down the test number on the black board right before the scheduled test time.
- 2) Remind and monitor students to sign up on the name list for attendance and authentication. If necessary, check on their one-cards to make sure they are whom they claim.

2. During the exams:

Some unexpected incidents may occur during the exams, for instance, network jam makes the student lost connection to the server, students shut down the browser abruptly without following the instruction. Once the students try to log back to the exams, they

will be led to the exam re-login page and asked to enter re-login password and the rest of test time. The students can't log back into the exam without knowing the re-login password.

Steps to log students back to the exams:

- Input the re-login password.
- Assign the rest of test time for students. The last login time will be given and displayed on the page. The proctor must calculate and assign the rest of available test time for students based on the formula “minutes left = Scheduled test ending time - Last Login Time. This solution is not completely objective and accurate. You should make your own decision according to the situations.

Chapter 8: Conclusion and Acknowledgement

8.1 Conclusion

The creation of this test system provided a much more challenging project than I had anticipated. A lack of hands on experience with Microsoft SQL Server and Visual Basic, the high-level security needs within a limited facility environment meant a lot of difficulties for me. Fortunately, with the help of online resources and tutorials, I was able to come up with viable solutions to the many problems I faced. From this aspect, this project was really a valuable learning process for me.

Although the system works, it's far from perfect. It's my first time to handle such a real life application project independently. Looking back, there are a lot of pitfalls left. First of all, object-oriented programming didn't get well used in the system design. It will certainly bring up hard times in the system maintenance in the future. Second of all, I failed to make a feasible timetable, so time was running out while I didn't come up with "Help and Instruction" component, which is available in USMLE test. I hope once the school approves the project proposal those unsolved problems can be brought to table again.

8.2 Acknowledgement

This AIMS Online Testing System was developed at OED office, the School of Medicine, UNC Chapel Hill. I would like to thank my supervisor Donna Howard for her guidance throughout my work. I also thank for my colleague Linda Fisher for her tremendous excellent work devoted during the system testing. At last, I would like to thank all the personnel who attended the beta tests for their help and valuable opinions.

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Appendix A: Evaluation Form

Evaluation of the On-line Testing Application: Feedback

Office of Educational Development April 10 & 11, 2002

Please indicate your agreement with each of the following statements using the scale indicated below.

Use the following scale:

1 = *strongly disagree* 2 = *somewhat disagree* 3 = *somewhat agree* 4 = *agree* 5 = *strongly agree*

1	2	3	4	5
---	---	---	---	---

1. The general layout of the exam resembles the format of other standardized tests such as the USMLE Step 1 exam.

1	2	3	4	5
---	---	---	---	---

2. The overall layout of the application is straightforward & well organized.
(e.g., font size, readability, spacing)

Comments on Questions 1-2:

1	2	3	4	5
---	---	---	---	---

3. The login process should have an additional step, such as using the UNC secret test ID number.

1	2	3	4	5
---	---	---	---	---

4. The instructions are adequate.
(*note: there will eventually be a HELP button on each screen*)

Comments on Questions 3-4:

1	2	3	4	5
---	---	---	---	---

5. Navigating through the exam is easy (using the NEXT, PREVIOUS and MARKED QUESTION buttons)

1	2	3	4	5
---	---	---	---	---

6. The process of 'marking' questions is clear.

1	2	3	4	5
---	---	---	---	---

7. Returning to a 'marked' question from the review page is easy.

1	2	3	4	5
---	---	---	---	---

8. The 'review' page is easy to use.

Comments on Questions 5-8:

1	2	3	4	5
---	---	---	---	---

9. It is clear that the 'repeated narratives' apply to more than one question.

1	2	3	4	5
---	---	---	---	---

10. Images should appear at the top of the page.

1	2	3	4	5
---	---	---	---	---

11. Having to scroll down the page for long questions is acceptable.

1	2	3	4	5
---	---	---	---	---

12. The 15 and 5 minute time-out warnings are obvious.

Comments on Questions 9-12:

Please check YES or NO for each of the following statements.

YES NO

<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------

13. Should students accept the honor code before taking an on-line exam?

<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------

14. Should this application, or a similar one, be used for on-line testing at UNC School of Medicine?

15a. Did you try to exit or close the exam at any time?

15b. If so, were you successful?

Comments on Questions 12-15:

GENERAL COMMENTS:

Appendix B: User Feedback Report

Feedback on the On-line Testing Application

Office of Educational Development April 10 & 11, 2002

Questions	Mean (N=18)
Scale: 1 = <i>strongly disagree</i> 2 = <i>somewhat disagree</i> 3 = <i>somewhat agree</i> 4 = <i>agree</i> 5 = <i>strongly agree</i>	
1. general layout of the exam resembles format of other standardized tests such as the USMLE	4.72
2. overall layout of application is straightforward & well organized	4.44
3. login process should have additional step, such as using the UNC secret test ID number	3.17
4. instructions are adequate	4.50
5. navigating through the exam is easy	4.67
6. process of 'marking' questions is clear	4.72
7. returning to a 'marked' question from review page is easy	4.78
8. 'review' page is easy to use	4.67
9. clear that 'repeated narratives' apply to more than one question	4.28
10. images should appear at the top of the page	3.89
11. having to scroll down the page for long questions is acceptable	3.61
12. 15 and 5 minute time-out warnings are obvious	3.00
<i>Yes or No response</i>	<i>Percent</i>
13. Should students accept the honor code before taking an on-line exam? [Yes]	100.00
14. Should this application, or a similar one, be used for on-line testing at UNC School of Medicine? [Yes]	100.00
15a. Did you try to exit or close the exam at any time? [Yes]	72.22
15b. If so, were you successful? [No]	100.00

Synopsis of Comments:

Questions 1-2: general layout was straightforward and easy to use; format resembled the board exams; 8 respondents said that the font needs to be larger throughout the system, particularly on the laptop; resolution on laptop may be a problem for high resolution images such as path or histo slides; 1 respondent thought the screen was too cluttered; subscripts didn't look right; 1 respondent wanted to click anywhere on an answer to select that answer.

Questions 3-4: instructions were easy to understand and follow, although 1 respondent felt they were slightly confusing; 1 respondent suggested that we include screen samples in the instructions, or a demo; 4 respondents felt that an extra login step should be added (eg, test ID, password or typing in birth date); 1 respondent felt that PID was enough; cursor should automatically start in the PID space when you enter the page.

Questions 5-8: marking & reviewing questions is a positive feature that one wouldn't have on paper; layout is similar to boards, although new students may need instructions about 'marking'; 1 respondent commented that the red & yellow blocks on the review page were not aligned; 1 respondent was not sure what the 'back to question' button meant; process of marking questions not clear to 2 respondents; most respondents had no problems navigating through exam, although 1 would prefer to use arrow keys for navigation.

Questions 9-12: almost all respondents had problems reading the 15 & 5 minute warning messages, which did not display correctly on the laptop; 3 respondents found the 15 minute warnings distracting, while 4 felt that the warnings were not obvious enough; 7 respondents would prefer not to scroll down the page to read further text; 2 respondents suggested pop-up windows for images, or placement of images on left or right of screen; 1 respondent wanted annotation capabilities; 1 respondent was frustrated by not being able to 'batch fill' answers; 1 respondent was confused about the use of 'repeated narratives'.

Questions 13-15b: 72.2% of the respondents tried to close the application during the exam, and comments indicated that none of the respondents were able to log back into the exam; 5 respondents asked for assistance from the proctor to log back into the exam.

General Comments: the overall comments about the application were very positive--great idea, should be implemented, on-line tests may be easier to use, better images, quicker scores, will be excellent preparation for the boards; 5 respondents felt that the drop down boxes for extended matching questions should only include the correct number of options.