ZSTEST an on-line testing solution

By

Zachary J. Storer

Submitted to
the Faculty of the Information Engineering Technology Program
in Partial Fulfillment of the Requirements for
the Degree of Bachelor of Science
in Information Engineering Technology

University of Cincinnati
College of Applied Science

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Zachary J. Storer — Date 5/30/01

Russell McMahon, Faculty Advisor — Date 6/1/01

Department Head — Date 5/30/01

Acknowledgements/Dedication

The people who helped to make this project a success are mainly the professors, current and former, at the University of Cincinnati College of Applied Science. Without their teaching and help this project would have never been accomplished. Dr. Ashraf Saad was a particular help during the formulation of the first Special Topics in IET course. Professor Russ McMahon was an enormous help in learning the technologies to complete this project and make it work on such large-scale systems as MS SQL Server 7.0.

My wife and family have been most important in this long journey to completion of not just this project but my degree and education. As an Information Technology professional, I will be a lifetime learner and this project is just the beginning of global projects to come.

Thank you to all who have helped me to learn and stay focused on school and the light at the end of the tunnel.

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Abstract

The product ZSTEST was developed to meet the need for an on-line testing system. My company ZS Computer Services has been developing a real world testing and certification website to test people on real world computer knowledge. The business needed a backend to test and score individuals on their knowledge. The current products available did not meet the flexibility requirements and the needs of the business. ZSTEST is the solution to that need. A secondary market for the product was later realized through discussion with educators at local schools and universities. Many schools are developing distance-learning programs and also have a need for a scaleable testing system. The schools have a need for a centralized intranet based testing system to allow professors flexibility in creating tests and storing results. Through logging and data storage, instructors are able to find commonly missed questions and test scoring statistics.

The software system relies on MS SQL Server as a database backend for the package. The front-end was programmed in Visual InterDev using Visual Basic Scripting. The server uses Internet Information Server and ODBC to allow Active Server Pages communication with the database backend. The database houses information about the user, as well as question and test data. Separate tables store user session information that allow queries written in Transact SQL the ability to output statistical data to the end-user. The data can be used by an instructor to see frequently missed questions and review them for wording and accuracy. With the creation of a paperless testing system, all information is streamlined and stored in an easy-to-access central location. The system simplifies an instructor's ability to create tests by having a central bank of questions to choose from. Overall, the system uses virtually every aspect of the IET program at OCAS.

ZSTest

1. Purpose: To develop a customized, Web-based, testing system.

There are two main areas that established the need for customized Web-based testing software. First, I have developed a company that tests and certifies individuals on their real world knowledge. This company is a Web presence only and needed a system for testing individuals and storing related information. Second, schools such as the University of Cincinnati (OCAS) needed software to test students from a workstation interface. Students felt that classes dealing with technology should incorporate that technology throughout the course. A survey of 46 college students in Computer Science programs revealed that 91% of students felt a computer based testing system would be more in line with the goals of their computer related courses (1).

In order to create a marketable robust system; the database had to be scaleable, the software had to be standard/intuitive (using widespread common coding language), and the system had to be robust.

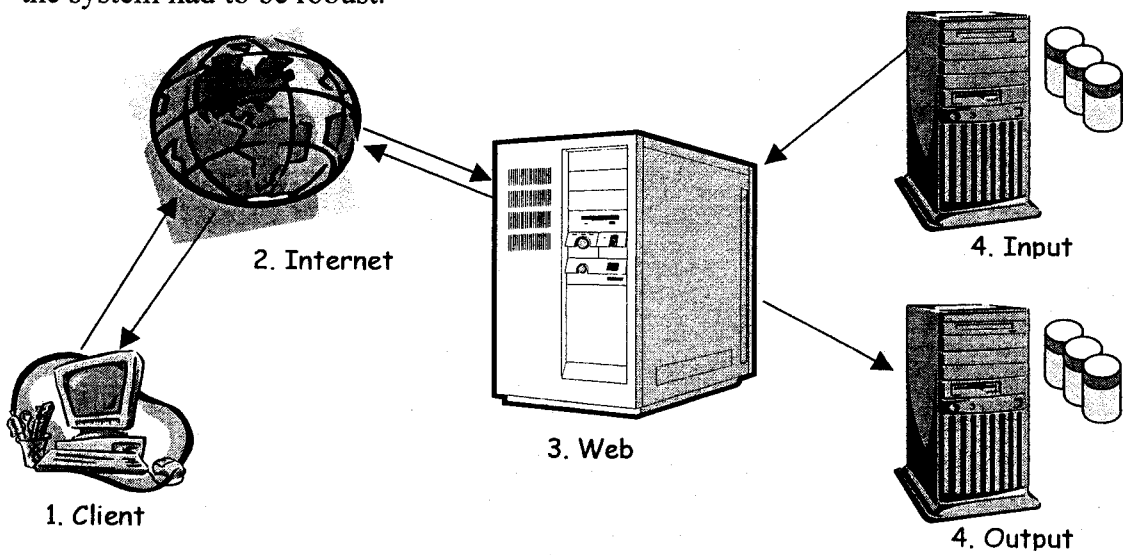


Figure 1. Graphical depiction of project

2. Review of the Literature

A large number of sources were referenced and used to establish the feasibility of this project. First, in viewing other testing programs, I was able to find deficiencies and strengths to use during the design phase. Second, I was able to establish a need for a testing system through surveys and student polling.

2.1 RWI Inc.

There is a need for Real World Institute Incorporated testing solution:

With the development of this new business, I have the need for an online testing system to use for certification. Windows NT Magazine shows MCSE Status has become easy to obtain (2, 35). A survey of IT professionals shows they believe that certifications do not show a test of ones skills accurately (3). A survey of IT managers shows managers need a baseline to judge new hires, and that certifications are a way to summarize an individual's skills (4,13). Networking World Journal shows Certifications are too easy to obtain (5, 57).

2.2 Market system to schools

There is a need for non-paper solution:

I have had various instructors from different schools show an interest in this system. Instructors from the University of Cincinnati, Xavier University, and Lebanon High School have expressed an interest in using a product of this type. There are already some services on the Internet that perform testing. However, these products such as VLT (6), DiscoverySchool.com (7), and Distance Learning (8) do not allow in-house, intranet-based testing. Also, canned programs such as these are seldom an actual fit with what schools need in flexibility.

2.3 Feasibility of Server/Database system

In establishing a need for this software several authoritative references for system design were consulted. Microsoft articles on Internet were reviewed for MS SQL Server 7.0 compatibility information (9). MCP Magazine had an article laying out possible IIS/Interdev designs (10). Among the literature reviewed, I surveyed and questioned a large number of individuals within my corporate setting. The Oracle Team at International Paper's Knightsbridge facility were asked about the bandwidth needed to sustain an ODBC connected system of this nature. International Paper's applications development personnel were asked about possible snags awaiting the conceptual design of this application. Finally, a survey was given to International Paper Web Development Team asking if the proposed project using specific platforms listed was feasible. All of the surveys and question responses were very positive and definitive.

3. The Solution

I have created a web-based testing system using Visual Interdev 6.0 on IIS. The system has a SQL Server 7.0 backend to house the input and output database. There can be client connections through the Internet and Intranet. The system is TCP/IP based and scaleable. Administrators are able to update and alter information remotely. Administrators and instructors are able to download/read the output of student test information over the web as well as through the intranet.

The system solves each element of the problem through specific software/hardware implementations. The housing of data problem is solved by SQL Server, TCP/IP, ODBC connections. Intra/Internet connections solve the network communications problem. Using Interdev as the primary interface between the student and the database solves the

user interface problem. The forms and screens were designed to be user friendly and easy to use.

3.1 Description and intended usage

The company intends to market this product to schools and businesses as an educational testing system for use over the Internet or through an intranet. The system will allow an instructor/educator to input test questions and answers, then allow an employee/student to logon and take a specific test. The system logs user answers and grades to a SQL database where the instructor/educator can logon and retrieve the student scores and testing statistics.

The system runs on one or more server machines with various software packages installed. The client's system needs to have SQL Server 7.0 installed on Windows NT with Internet Information Server 4 or greater. The target machine contains a minimum of one Network Interface Card, 32MB of RAM, 1GB Hard Drive, and a Pentium Processor. The client will need to have client licenses for Windows NT Server and SQL Server 7.0. The server and software can be setup for the client's location by ZS Computer Services and can be maintained by them for additional funds. ZSTEST is a modular program, the base install allows up to six instructors and tests. Additions and add on packages are available to scale the software application up to the site's needs and specifications.

3.2 User profile

The target use group for this product is split between two groups of individuals, administrators and test takers.

3.2.1 Test Takers

There will be students attending a school or university using ZSTEST, and there will be employees of a company using ZSTEST. The test taker should have basic point and click knowledge of a computer. They should also have the skills required to take a typical multiple-choice test. The test taker will be required to login and select a test. The test taker will also be required to take the test within the allotted timeframe and print or copy their score for their records.

3.2.2 Administrators

There will be instructors or professors in a university or corporate-environment using this product. The administrator will be required to input test questions and answers into the database. The administrator will also need to download and review statistics and grades associated with their students' scoring. They will need basic training on the system as well as basic computer knowledge.

3.3 Design protocols

3.3.1 Organizational scheme

The organizational scheme is seperated into each communicating piece for calrity.

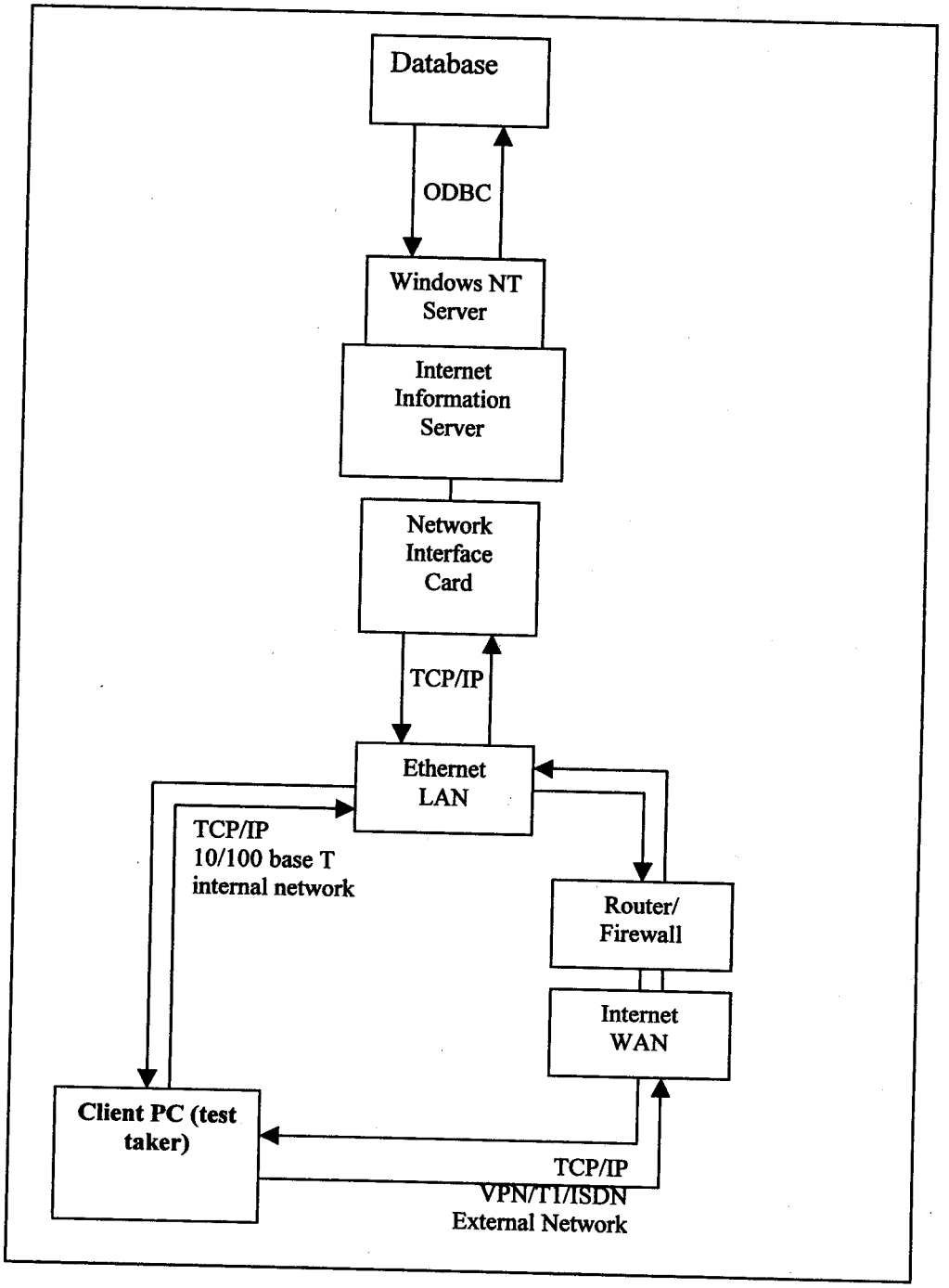


Figure 2 Graphical depiction of data flow

3.3.2 Interface design/navigation

Flow of pages for intra/Internet on Internet Information Server.

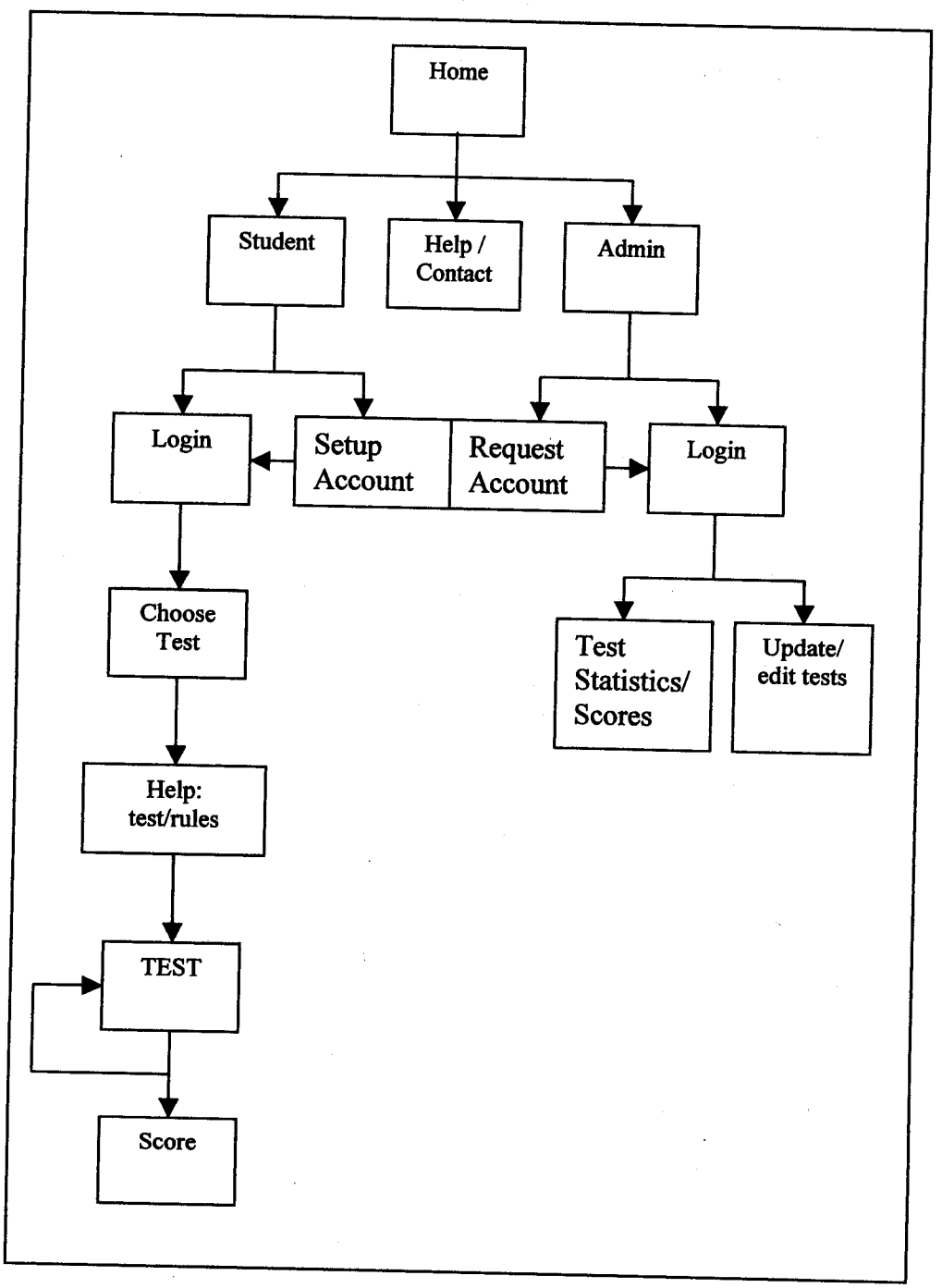


Figure 3 Graphical depiction of Web movement

3.3.3 Icons/graphical symbols

The system will not be very graphics oriented. The pages and data are the most important part of this project and fast efficient flow of test information is paramount. There are navigation buttons and interface but they are simple and user friendly. For instance, below is a picture of the button a test taker would press to move on to the next question.

Figure 4 Example button from project

When an individual wants to choose an answer as correct from the choices they are given the button next to the answers will change from  to  .
All of the interaction buttons are labeled with text that simply states the purpose of the button. The option for a user to login is labeled "Logon", to move to the next question the user clicks "Next->".

3.3.4 Color Scheme

Background colors are light with a slight pattern watermarked into them. The foreground colors are complimentary to the background and are either black or dark orange. The colors are slightly modified stock graphics from the "RAY" color scheme in Visual Interdev 6.

4. Deliverables

4.1 Specific goals

1. Provide a robust SQL based testing system.
2. Provide a system where the interface is .ASP pages and communicated through Internet Information Server running on Windows NT.
3. Provide an intuitive interface for low-knowledge-level end-users.
4. Provide an easy to update and edit interface for instructor's tests.
5. Provide a system that logs user activity and scoring for data retrieval and modeling.

4.2 Specific modules/components

1. SQL Server tables holding test information
2. SQL Server table holding user information
3. SQL Server table holding test scoring information
4. ASP Pages following the prior mentioned flowchart.
5. ASP Help Pages.
6. ASP Login and Setup Pages
7. ASP Administration pages to bridge the gap between SQL Server and the Instructor's computer for editing and review.
8. ASP looping test sheet for actual test taking.
9. ASP Scoring page for student. They can see their grade immediately.

5. Design and Development

5.1 Budget

The design of this project entailed four specific points; budget, timeline, software, and hardware. The budget for the project was laid out into two distinct areas. The first budget area was for software needed to develop the project. Visual Interdev 6.0 was needed for web development. Windows NT 4.0 Server was needed for an operating system to house the testing system. Along with Windows NT is Internet Information Server, this item was free with the Windows Option Pack. Finally, Microsoft SQL Server 7.0 was needed to house and store the database tables for the project. The budget, split into two areas, is located in appendix A.

5.2 Timeline

The timeline for completion of this project was somewhat different from the original outline of time and resources. As the project was constructed, the workload times were more easily estimated and achieved. Some of the items that took longer than planned were the development of the final reporting and documentation. The overview for the project from the beginning of Senior Design 1(Sept. 2000) is located in Appendix B. The prototype was basically completed and roughed in, with basic features. The prototype timeline was spread over the course of my first few years at UC. Therefore, the timeline from initial concept to prototype build was undocumented and unreliable. The timeline outcome of the project in simple graphical representational form is located in Appendix C.

6. Proof of Design

The software designed to meet the discussed deliverables, has been reviewed for its completeness and adequacy. Each deliverable has been met in one or more ways within the testing system. All of the goals have been met and obtained. Project review and polling provided the following results. Twenty-seven individuals representing an average user community were asked to fulfill one of the two user profiles discussed earlier. Three individuals were asked to be system administrators, and the other twenty-four were asked to represent the test taking population.

Proof of design survey

	Admin Y	Admin N	Student Y	Student N	Totals Y	Totals N	
A. Were you able to intuitively access question trending information?	2	1			2	1	3
A. Were you able to easily add new questions to the test bank?	3	0			3	0	3
A. Were you able to update your tests?	3	0			3	0	3
A.S. Were you able to login easily?	3	0	23	1	26	1	27
A.S. Was the interface intuitive?	2	1	22	2	24	3	27
A.S Were you able to connect to the web testing system error free?	3	0	23	1	26	1	27
A.S. Was the formatting of the web pages too busy?	0	3	3	21	3	24	27
S. Were you able to setup a user name and password?			24	0	24	0	24
S. Upon test completion were you able to see your test score results?			24	0	24	0	24
S. Do you feel there was a logical flow to the process of taking a test?			23	1	23	1	24
S. Did the help pages provide you with adequate help?			20	4	20	4	24
S. Was the testing page intuitive?			21	3	21	3	24
S. Were you able to take a test successfully?			24	0	24	0	24

Figure 5 Survey results for proof of design poll

6.1 Meeting the specific goals of the project

The first goal was to provide a robust SQL based testing system. This objective was met by coding error-handling into the .ASP pages and to use both SQL Server 7.0 and Transact SQL to deliver information and compile results for the end-user. Providing a robust foundation on which the system is housed also contributed to meeting this goal. The system is completely scalable, providing the end-user the ability to run each different

piece on completely separate computer systems, and having virtually unlimited user accounts and test banks loaded on SQL Server by way of test module add-ons.

The second goal was to provide a system where the interface is Active Server Page(ASP), communicated through Internet Information Server running on Windows NT. This was accomplished; however, added functionality was achieved by allowing the system to run on a standard Windows machine using Personal Web Server and connecting to a SQL database remotely.

The third goal was in providing an intuitive interface for low-knowledge-level end-users. This item was achieved by slimming down the web interface and giving users only the options they need to complete their task. By combining the results of the post-design survey, an overwhelming majority of users agreed that the system was easy to use.

The next goal of providing an easy to update and edit interface for instructor's tests was met by the addition of MS Access forms and queries. Since this was an overall goal for the project, I added the increased functionality of making ODBC MS Access connectivity to the database. This allows the system the possibility to run on a standalone server with IIS and SQL 7.0 and provide remote access to that server via ODBC using MS Access.

The final goal was to provide a system that logs user activity and scoring for data retrieval and modeling. This was achieved by logging every choice a student makes into database tables. The tables are relational and joined on one or more fields making all data available, easy to access and compile. Furthermore, I wrote several SQL queries and output strings into the system to allow for stock data output.

7. Screen Captures

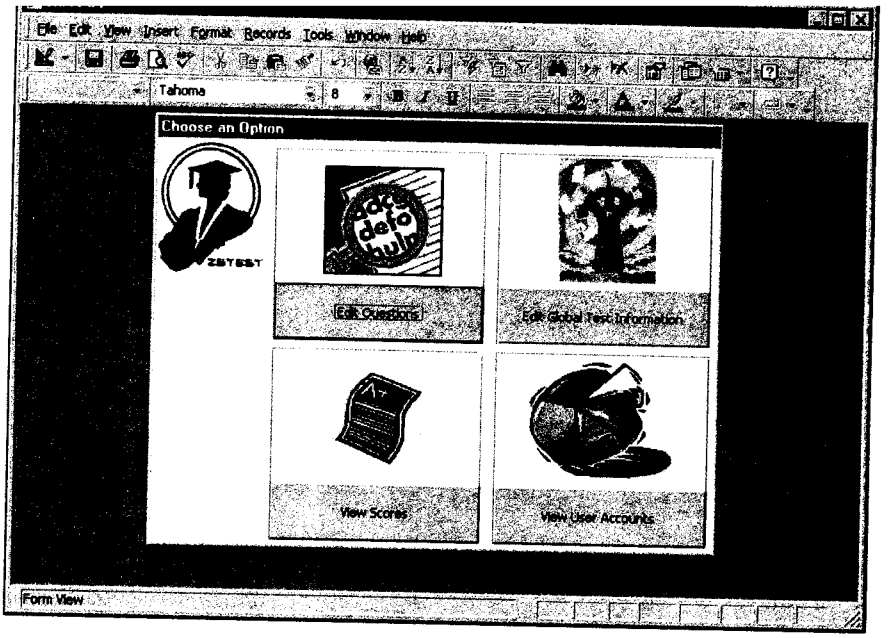


Figure 6 Access database switch form

This is the Microsoft Excel main switchboard form. From here an administrator can choose one of the four options to view scores or perform administration to the database.

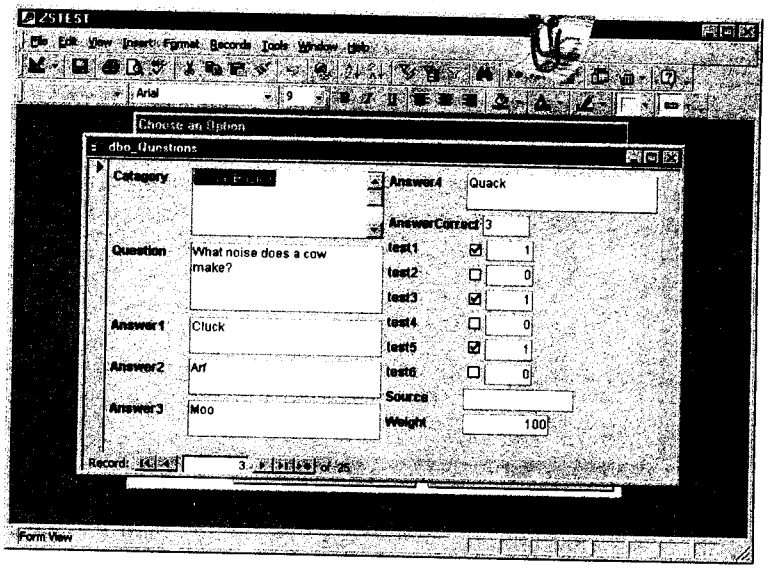


Figure 7 Access database questions form

The Questions form is where instructors can add and remove questions from various tests.

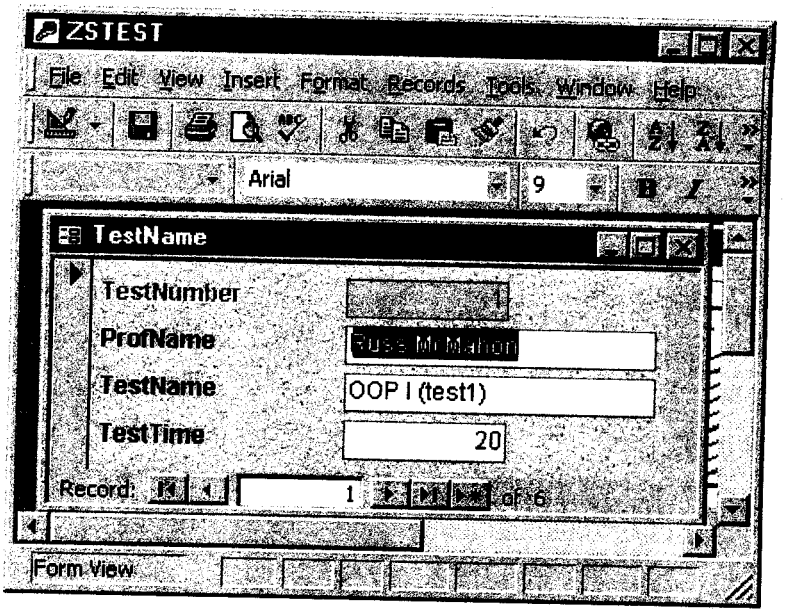


Figure 8 Access database test information form

Figure eight shows the layout of the Global Test Information form. This window allows the instructor to change test information specific to one of the six module tests. It also allows the instructor to alter the allotted testing time.

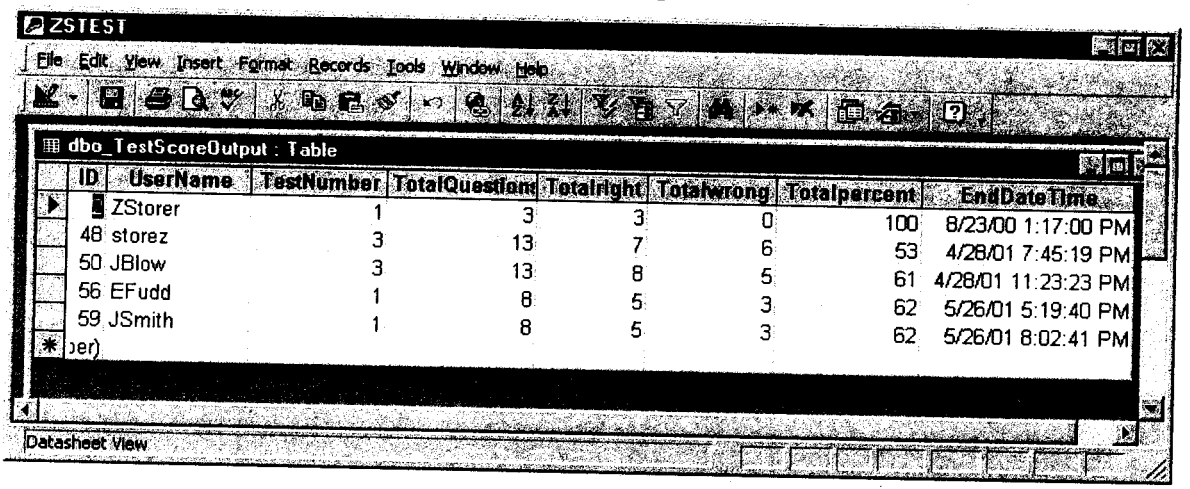


Figure 9 Access database test score output screen

The Score output allows an instructor to read the scores of individuals who have taken tests using the system. It also shows what number was taken and the ending time.

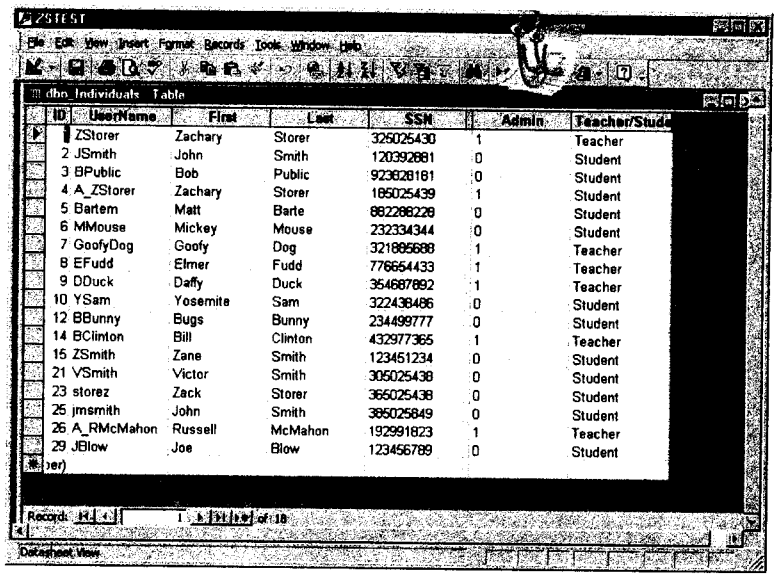


Figure 10 Access database test user information screen

The final table in the access database holds information about the individual accounts stored on the system. This is also the screen used to upgrade a new account to an Admin/Teacher account.

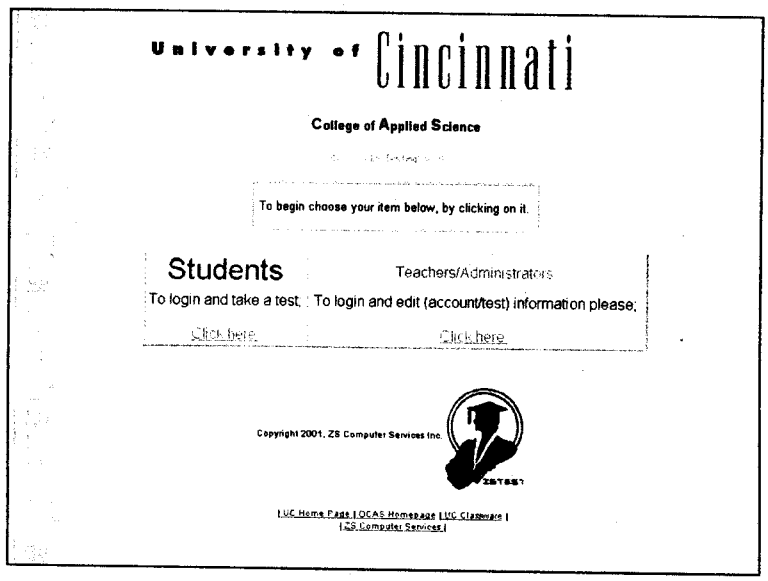


Figure 11 Opening web page

There is a simple two-direction flow to the web-testing site. A user can either choose the student route, or they can choose the administrator route.

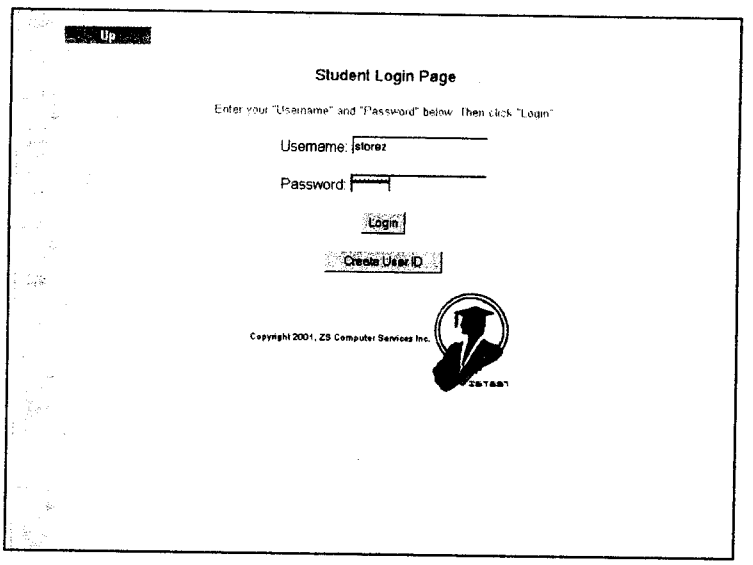


Figure 12 Student login web page

Here the student has the option to either login or create a new user ID. Once their new user ID is created they then have the ability to login and take tests.

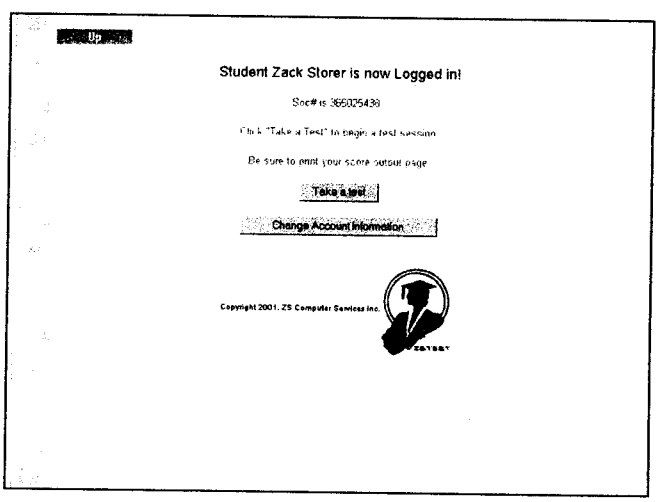


Figure 13 Student option web page

The student option web page shows that the student is logged in and outputs account information. The student can now go to the testing pages or alter information.

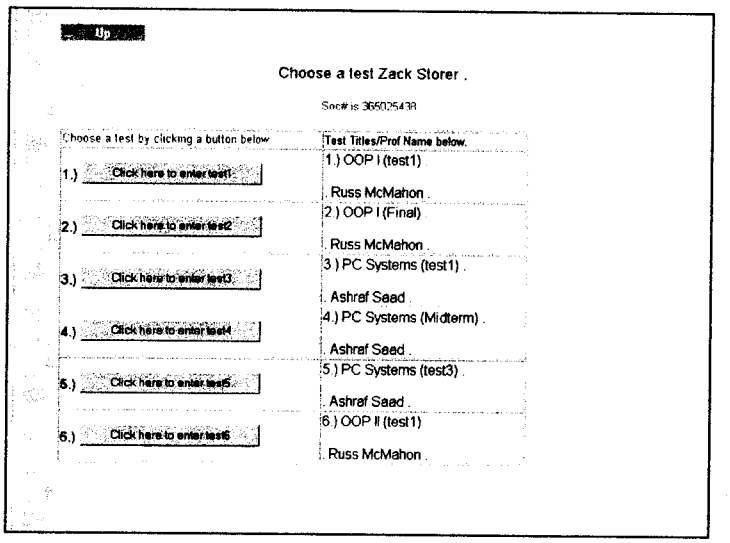


Figure 14 Student test choice web page

The test choice page reflects all six tests included in the first module. The page is dynamically created and linked.

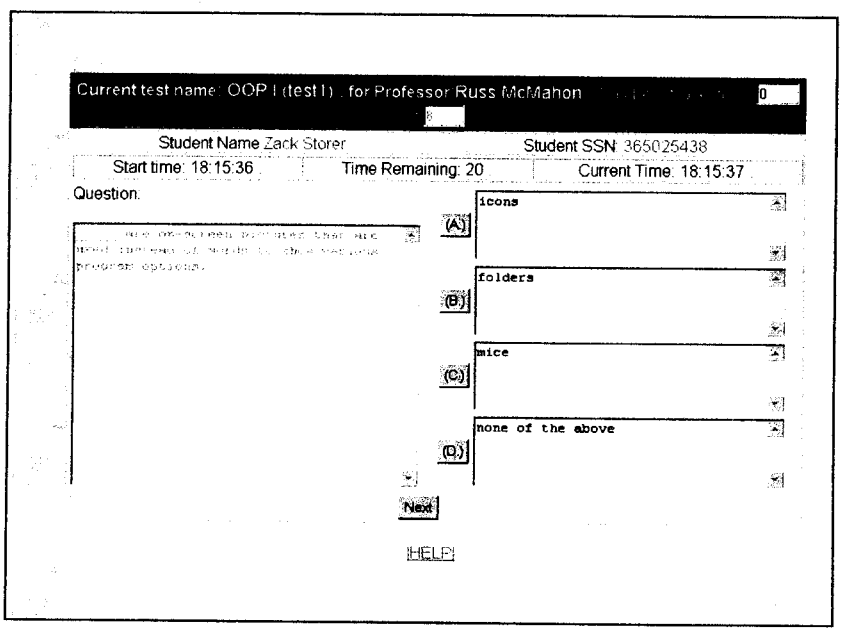


Figure 15 Student test web page

The test page is the heart of this system; it allows the test taker simple and easy to understand functionality.

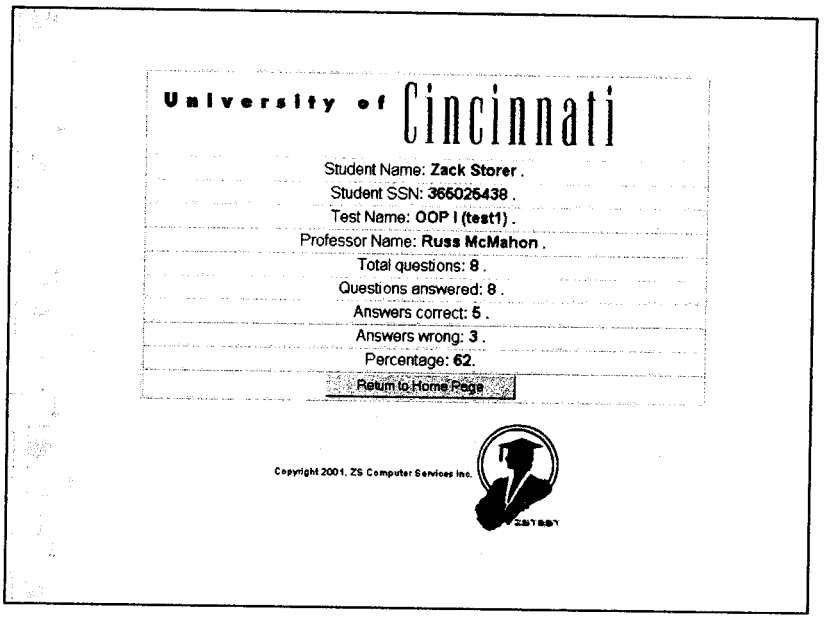


Figure 16 Student score web page

The scoring page allows the test taker instant results upon test completion. It gives the taker the ability to print their results for archiving purposes.

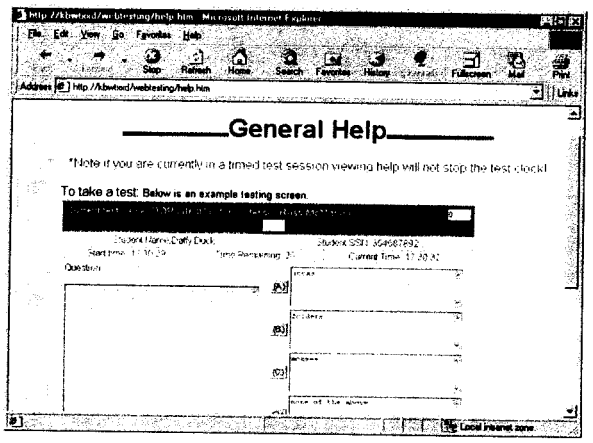


Figure 17 General help web page

The general help page provides the user with information on how to perform functions and the flow of processes. It aids them in using the application.

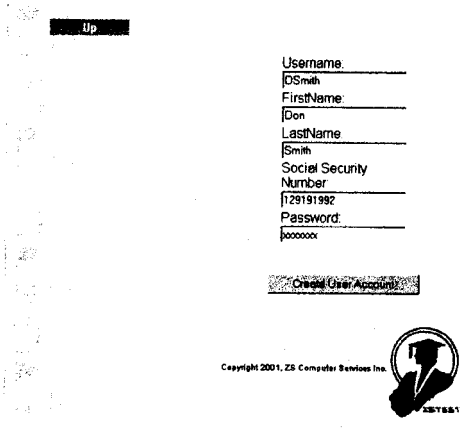


Figure 18 Create ID web page

The create user ID web page is available to administrators and students. This page allows them to create and ID and begin taking a test. If an administrator or teacher creates and ID they then need to be upgraded to administrator status by a current administrator.

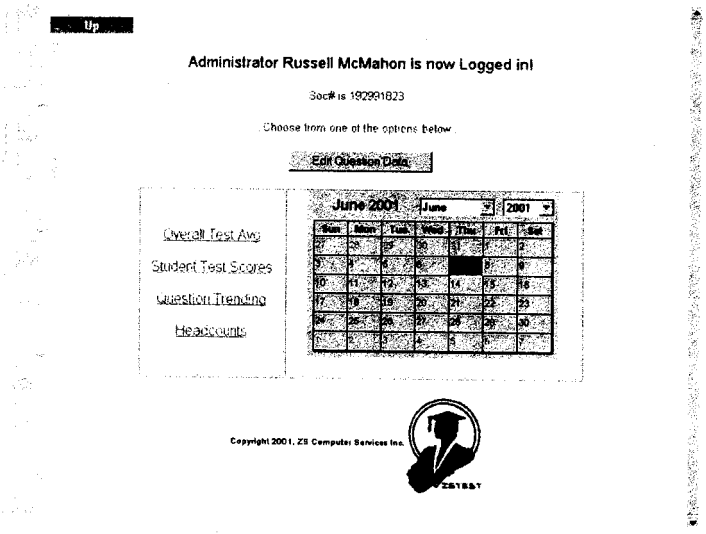


Figure 19 Administrator home web page

Once an administrator is logged into the system, they are directed to the above web page. From here, they are shown a web calendar and allowed to alter test questions and view any SQL stored queries.

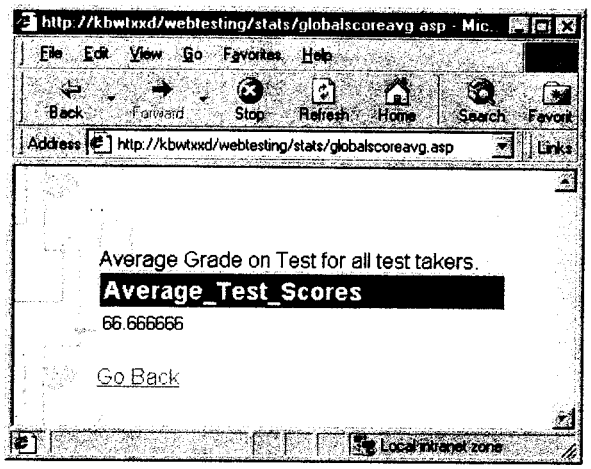


Figure 20 Average test score web page

Figure twenty shows give an output of average student test scores.

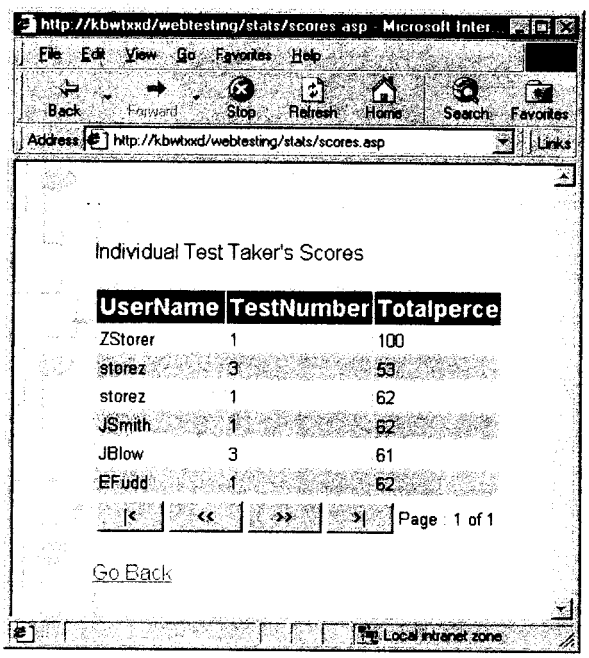
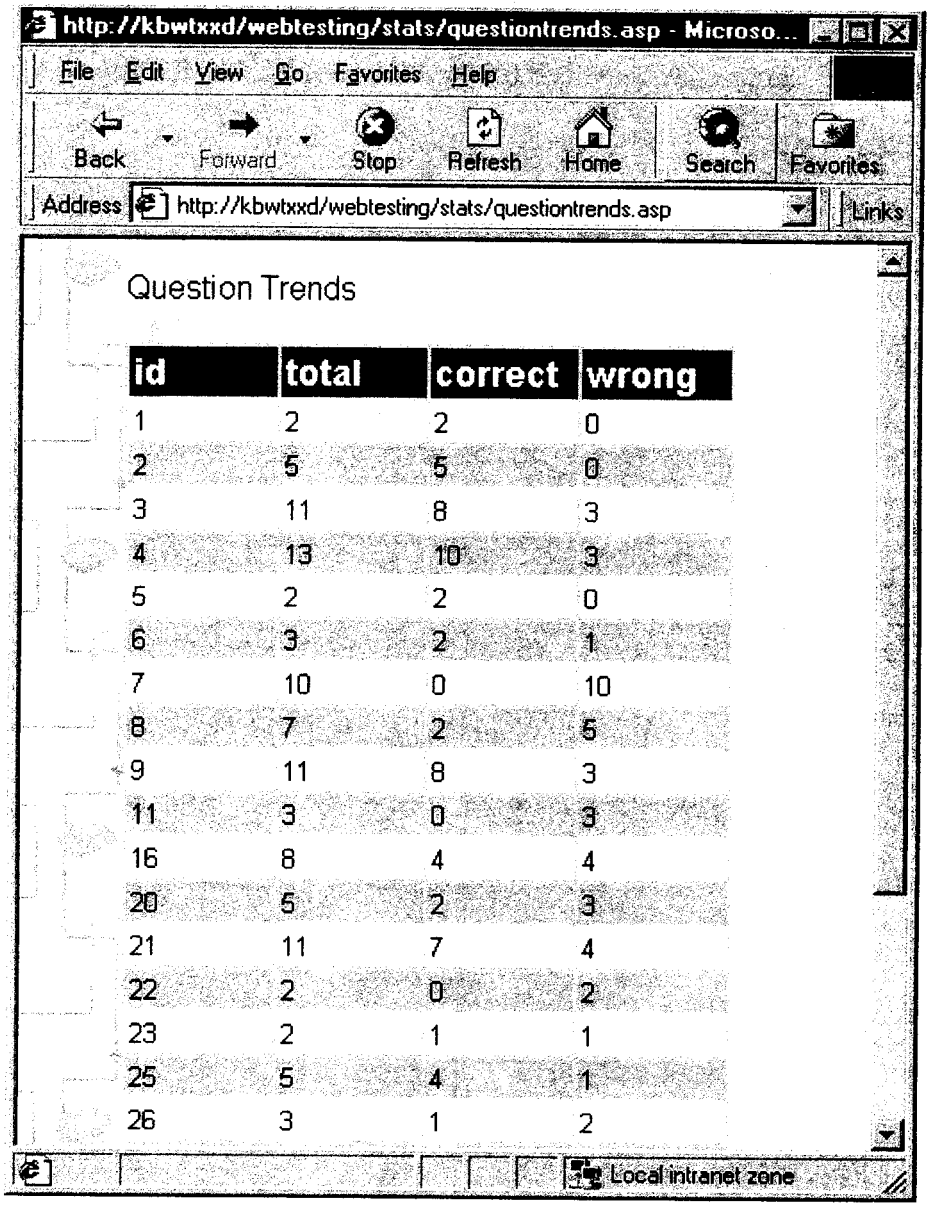


Figure 21 Student test score web page

The above page shows individual tests taken and what the results of those tests were. The page allows for easy recording and book keeping.



id	total	correct	wrong
1	2	2	0
2	5	5	0
3	11	8	3
4	13	10	3
5	2	2	0
6	3	2	1
7	10	0	10
8	7	2	5
9	11	8	3
11	3	0	3
16	8	4	4
20	5	2	3
21	11	7	4
22	2	0	2
23	2	1	1
25	5	4	1
26	3	1	2

Figure 22 Question trending web page

The final page offered to an instructor is one that allows question trending. Having this ability, and instructor can view commonly missed questions and revise them. Having this trending information spanning across all tests also allows the instructor to see what areas need more review time in class and what areas might not need as much.

8. Conclusions and recommendations

Overall, the project came together as promised and met all of the deliverables. I was very happy with the use of Visual Basic Scripting and Structured Query Language to complete this project. This was a huge learning experience for me and it tested virtually all of the IET knowledge obtained at the University of Cincinnati. Database and Advanced Business Applications knowledge, as well as Visual Basic and Multimedia Design were used throughout this application.

However, if I were going to tackle this project again I would do several things differently. When I began to layout the design for this system, I planned on using many of Visual Interdev's rapid development tools to assist in construction. In the end, Visual Interdev turned out to be more of a hindrance than help. I placed countless pieces of VB Script throughout the many ASP pages. This worked great, as long as my page update and corrections were done in strictly in code form. If I made changes using the graphical interface for object placement, the system would reformat all of my VB Script causing abundant problems. Also, I did not end up needing the NAVBAR object to create a navigation scheme linking my WebPages. I finally hard coded all of the page references, thereby eliminating the need for MS FrontPage Extensions to be installed on the server.

Some things that went very well in development were using survey data to formulate a project plan for the layout of the project. Potential users had a good amount of input on simplified functionality and content. Also, by using unbound controls within the website, I was able to add even more scalability to the system. Thought it was not done for class, it would be very easy to use MS Access as the database backend with only a few small changes. This functionality assists the application's ability to scale down to a smaller environment.

Appendix A.

Budget

(*Note all prices are with OEM discount, ZS Computer is a member)

- Specific software needs:

Windows NT Server	$	840.00
Windows NT Workstation	$	120.00
Windows ME	$	100.00
Microsoft Excel 2000	$	6.00
Microsoft Visual Interdev 6.0	$	220.00
Microsoft IIS	$	0.00
Microsoft SQL Server 7.0	$	197.00
Internet Explorer 5.5	$	0.00
Total =	$	1483.00

- Sample of specific hardware needs for client installation:

PII233 CPU	$	45.00
PII Motherboard	$	102.00
128 MB RAM	$	102.00
2 GB Hard drive	$	56.00
10/100 NIC Card 3COM	$	42.00
Videocard	$	24.00
Keyboard	$	15.00
Server Case	$	75.00
Mouse	$	5.00
Monitor 21"	$	138.00 used
DELL Laptop Latitude P3 350	$	425.00 used
LAN Hub OvisLink 8 port	$	35.00
RJ45 CAT5 network cables	$	24.00 (qty 4)
Total =	$	1088.00

- Actual hardware used in system production:

Dell Latitude Laptop PIII 350MHZ $ 425.00(used)
128MB ram, 6GB hard drive, NIC card

- Funding Sources

All capital provided by CSNG Inc.

Appendix B.

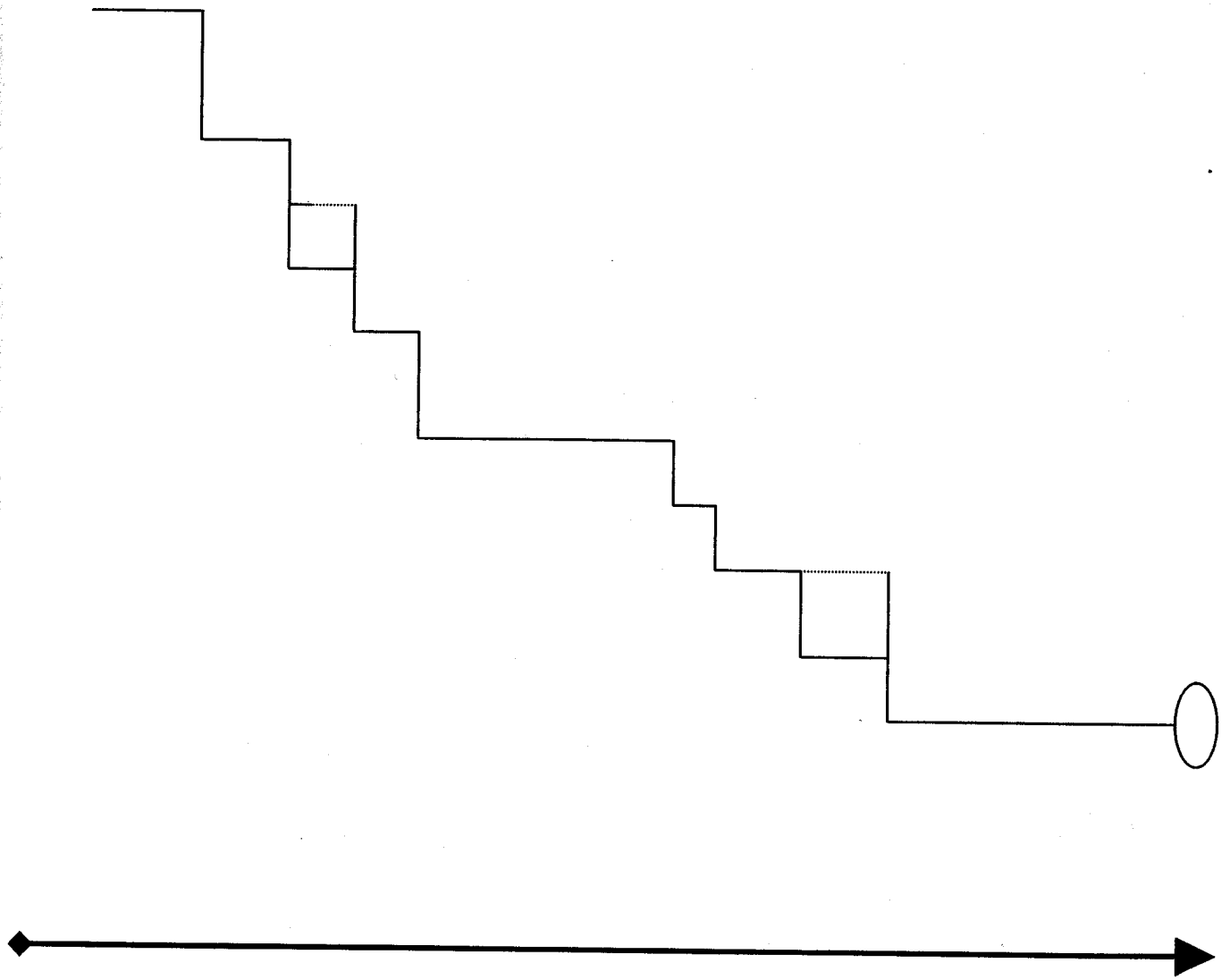
Gantt Chart Task Ids

Task id	Task	Predecessor	Effort (weeks)	Duration (weeks)
A	Prototype System	Done	0	0
B	Review Prototype	A	3	2
C	Layout Final Infastructure	B	3	3
D	Forms/Graphics	C	2	2
E	Create Final DB Subsystem	C	4	4
F	ODBC/NETWORK Subsystem	E	2	2
G	Build Software	F	10	10
H	Review/review security	G	2	2
I	Test for Errors/correct	H	2	2
J	User Review	I	6	3
K	Document/Deploy	J	7	7

Appendix C.

Gantt Chart Task Ids Time Flow

Critical Path = 34 Weeks



Glossary of Terms

OCAS	Ohio College of Applied Science
RWI Inc.	Real World Institute Incorporated
MS SQL Server	Microsoft's midlevel database product
Code	The language used to program an application
MCSE	Microsoft Certified Systems Engineer
MCP	Microsoft Certified Professional
ODBC	Open Data Base Connection
SQL	Structured Query Language used to interact with a database
Visual Interdev	Microsoft's rapid application development program for web design
TCP/IP	The transport control protocol used to allow communication between systems on a network
IIS	Internet Information Server, Microsoft's web server which runs on Windows NT
NIC	Network Interface Card
GB	Gigabyte, measurement of size
ZSTEST	The name of the testing solution application submitted for Sr. Design coursework
LAN	Local Area Network
Router	A network device used to direct data packets to the correct place
WAN	Wide Area Network
VPN	Virtual Private Network, Used for a secure connection over a WAN
ASP	Active Server Page
VB Script	Microsoft's web coding language contained within .ASP pages
UC	University of Cincinnati
NAVBAR	The web component Visual Interdev uses to allow automatic page linking
FrontPage Extensions	The IIS plugins used to allow the NAVBAR display.
CSNG Inc.	Combines Systems Network Group Incorporated

References

(1) Survey of Students 46 students in technology majors, through e-mail were surveyed. 91% of the students agreed on wanting technology throughout all courses. Survey performed by Zack Storer Oct/2000.

(2) Windows NT Magazine September 1998. *MCSE Paper production*. P35-7

(3) Survey of IT professionals, 27 International Paper Employees surveyed. 73% agreed that certifications do not portray skills accurately. Survey performed by Zack Storer Oct/2000

(4) Information Security Magazine July 2000. *Getting the skills.* P13-5

(5) Networking World journal July 1999. *To certify or not to certify.* P57

(6) http://www.vlearning.com/index2.html

(7) http://distancelearn.about.com/education/distancelearn/gi/dynamic/offsite.htm?site=http%3A%2F%2Fschool.discovery.com%2Fquizcenter%2Fquizcenter.html

(8) http://distancelearn.about.com/education/distancelearn/cs/examtools/index.htm?iam=metacrawl&terms=%2Buniversity+%2Bweb+%2Bbased+%2Btesting

(9) www.Microsoft.com/MCP/authorized/%login%%21=%System%design

(10) www.Microsoft.com/MCP/authorized/%login%%21=%Visual%Interdev%+Articles