A Network-Based Multimedia Computerized Testing Tool[+]

Il-Hong Jung, Hosoon Ku, and D. L. Evans[*]
Center for Innovation in Engineering Education
College of Engineering and Applied Sciences
Arizona State University
Tempe, AZ 85287-6106
email: {ijung, hosoon, devans}@asu.edu

Abstract

In this paper, we describe a network-based, multimedia, Quizzer or testing tool that has been developed for authoring and delivering electronic quizzes/tests. We demonstrate this tool and compare it with traditional paper-based tests. The tool has been classroom tested and will be available for potential users.

Quizzes are easily constructed, updated or built from test item databases by using this tool. Graphics (using several graphics file formats) for questions and/or answers are easily incorporated as are digital video clips (AVI files). This tool is well suited for pre- and post-exams, student assessment, and self-evaluations.

1. Introduction

Assessment and evaluation (A&E) are important elements in teaching and learning. These activities can, and should, consist of a variety of activities. Good educational practices dictate that assessment be done often and that results quickly be made known to the learner. For example, the current reform movement in calculus was started when assessment techniques other than the traditional problem-based examinations showed that what the students were learning was not what instructors thought they were teaching. The work of Hestenes [1] confirms a similar phenomenon in physics education.

A significant amount of an instructor's time is usually devoted to constructing and administering assessment instruments and scoring and evaluating the results. Most testing in engineering, as in traditional physics instruction, has traditionally been done on paper and marked by hand. Generally, instructors develop and collect test items in "item pools" or "question banks" [2] over the course of time. From these pools, instructors then select which items to use for particular test. After selecting the items, the instructor constructs the test and copies it for distribution to the students. After completion, the tests must be scored, a process that can stretch the feedback time to days.

---

[*] Director of Center for Innovation in Engineering Education

To reduce costs and increase efficiency, particularly in large classes, instructors often employ computer-assisted test scoring and analysis. One typical example is the use of optical mark scan form. Using the Optical Mark Reader (OMR), the instructor reads the test results into a computer and the computer scores the results. Use of the OMR still has the problems that it requires the generation and distribution of paper instruments and it can not provide immediate feedback.

Although computer-based testing tools have been employed for a number of years, the value for classroom teachers is just beginning to be recognized. Use of computer-based testing tools can not only reduce the clerical tasks involved in A&E but they can also improve the quality of the test and the comprehensive nature of the feedback to students. New approaches to create and deliver computerized A&E exercises are actively being researched; for example, several papers have been reported on this topic by Hubbard and Murphy [3], and Oakley [4].

With the use of computers becoming increasingly commonplace and communicating more readily with each other, it is likely that every computer eventually will be connected to every other. Indeed the INTERNET and World Wide Web (WWW) are well on their way to making this prediction a reality. In such a case, testing at a distance by computer will have become very easy and make sense. One example of this is the virtual university, where teachers and students "attend" by computer and may never meet. Some universities are already taking steps in this direction, and many businesses have started distributing assessment tests on their internal e-mail networks. Whether used in distance learning programs or alongside more traditional teaching methods, computerized testing will play an increasing role in measuring knowledge and validating training schemes.

In this paper, we describe a new *Quizzer* program, a network-based, multimedia, testing tool that includes capabilities for both authoring and delivering electronic tests. This tool is well suited for quizzes, tests, and self-evaluation exercises. Surveys and tests can be created without knowledge of the original authoring program. Surveys and tests created within *Quizzer* can be taken by people without any computer skills other than "keyboarding and mouse" skills.

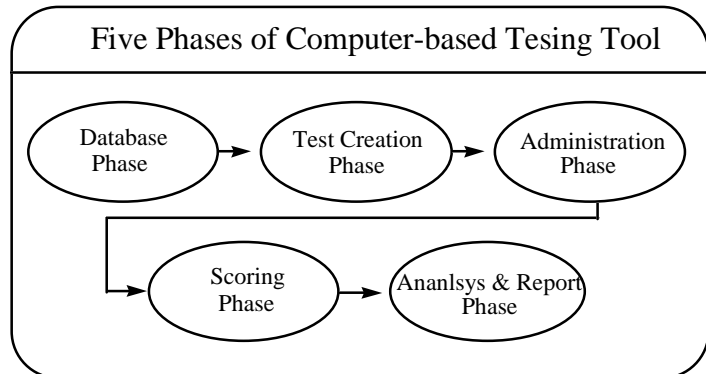## 2. Design of the Multimedia *Quizzer*

In this section, we present the design issues considered in the network-based, multimedia *Quizzer* program development. Little et. al. [5] formulated the seven main components of computer-based testing programs as following:

- developing a test item bank
- test construction
- test administration
- test scoring
- interpretation and analysis of results
- item analysis and test refinement
- reporting test results

To develop a useful and efficient computer-based testing tool, it is important to take into account all components listed above. These seven major components for computerized testing tools were

re-grouped into the five phases shown in Fig. 1. Brief explanations of the each phase are given below as they relate to the use of the *Quizzer*.

- Database Phase: Creates a database of test items. This phase is performed in the authoring mode by the instructor.
- Test Creation Phase: Organizes the test items selected from database into a quiz. This phase is performed in the authoring mode by the instructor.
- Administration Phase : Presents the test on network-based computers and allows students to take the test

Fig. 1. Five Phases of Computer-based Testing Tool

- Scoring Phase: Compares student responses to the answer key and grades the tests.
- Analysis and Report Phase: Prints or displays the test results, including optional item-by-item feedback, for the student and saves test results for the instructor.

The following issues were considered in designing and developing the *Quizzer* program to provide an easy-to-use, extensive testing tool for both instructor and student use.

1. Friendly and easy-to-use graphical user interface (GUI)
2. Integrate author mode (for instructor) and user mode (for student)
3. Easy to build database file from seven existing templates,
4. Easy to incorporate multimedia format (for graphics or audio/video inclusion)
5. Login phase - to provide secure identification of user, display user name on the screen
6. Random sequencing of questions - each user will have a different sequence of a test for higher security by using their ID as a seed (instructor initiated option)
7. Limited testing time - clock display (instructor initiated option)
8. Overview of test - student can easily jump from question to question, determine status of each question (marked or not marked), and mark sure/unsure for each item to give a easy monitoring of the test progress
9. End of test feedback - review mode can provide immediate feedback

Quizzer was developed using Asymetrix's Multimedia ToolBook™ [6] for Windows™ [7] platforms and network distribution. This tool has two modes of operation; an authoring mode for instructors and a testing mode for students. Instructors author new quiz databases using built-in templates (e.g., multiple choice with or without graphic, single and multiple response, true-false, matching question, numeric/short word answer), or they can edit existing databases of quiz problems.

Students take a quiz by logging in, loading an existing quiz database file, and beginning. They can easily keep track of their progress during the quiz (number of questions answered and which answers about which they are unsure). The results, at the instructor's discretion, can be reviewed and printed by the students for instant feedback when the quiz is finished. Test results

are automatically saved to text files in the instructor's choice of directories (on local drives or on network drives) in a form that can be easily analyzed on a spreadsheet. Test authentication and security issues have been considered.

3. Deployment of *Quizzer*

Developing an item bank with *Quizzer*

Quizzer has two modes of operation: **authoring**, which allows for the creation of tests, and **testing**, which is the mode that students must use to take tests. To create a database question file, an instructor logs in to authoring mode with appropriate password. After logging in to author mode, the instructor can load and update an existing test data file or create a new test database by selecting proper options from a welcome screen shown in Fig. 2.

When creating a new quiz question in either a new or existing data base, the instructor chooses the desired question template under the *Type* button. Figure 3 shows the seven template types available. On the chosen template, the instructor can simply type the question and possible answers (at least one of which should be correct) in the spaces provided. The instructor also marks the correct answer which is to be used by *Quizzer* when scoring the quiz. For example, the instructor might select *Single Response with Graphic* template. He/she then types in the question, possible answers, and either "points" to a pre-made graphic or digital video file or calls up a "paint" program to construct one on the spot. Figure 4 is a sample of a completed result that an instructor might build. This same question, answers and graphic presentation would be seen by a student taking the quiz (the black dot that the instructor has placed on the correct answer will not show, plus some of the buttons and options will be different). More details are available in an instructor's manual that is available with the *Quizzer*.
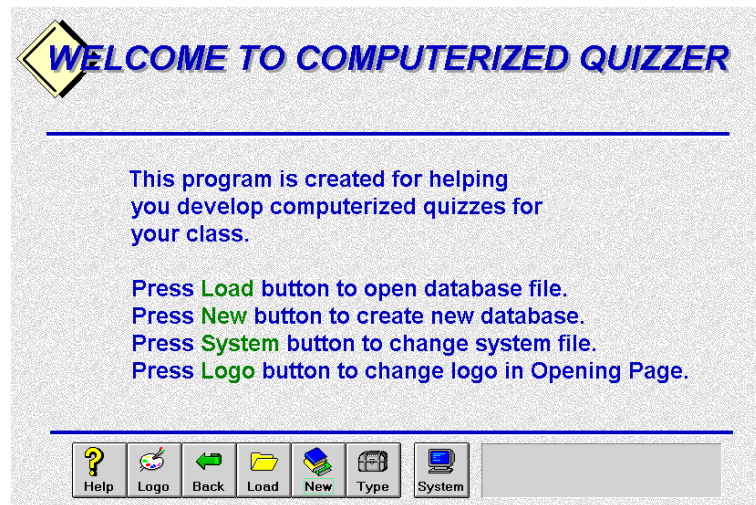

Fig. 2. Authoring Computerized *Quizzer*

To aid in working with existing databases, we have also provided a *Quiz Database Handler*, a utility tool that allows instructors to create another database file from an existing database without opening *Quizzer*. Instructors can use this tool to open the existing file, look up questions, designate the questions that he/she wants, and then save them to a new database file.

After a database has been completed, the instructor saves it to a file (with a .DBF extension). When the database is complete and saved, the instructor then tells *Quizzer* how it should construct a quiz from the database . This is done on the S*ystem Configuration* page which opens

when the database is saved (see Fig. 5). The *Save* button on this page saves this information in a quiz file which must be given a .QIZ extension. The S*ystem Configuration* options allow the instructors to make it clear to the student what subject the test covers, the number of questions, and time limits etc., so that the student has some confirmation that he/she is taking the correct test.

Delivering questions to participants

Currently, the easiest way to deliver a test to students is on a Local Area Network (LAN) with a file server. Participants sit at computers, load *Quizzer*, login with their name and ID number, choose the quiz they are to take, and proceed to take the test. During the test, students can easily check their status on a page that shows an overview of their progress. This page tracks which problems they have completed and which are left to be completed. Students can also see which problems they have noted as having an "unsure" answer. This "quiz status report" page allows the student to jump directly to any question for review or completion.

When the quiz is finished, students may go back to individual questions and review their answers, or see the

Figure 3
The Seven Templates

results as well as the correct answers to questions incorrectly answered, depending on how the instructor sets up these options on the *System Configuration* page.
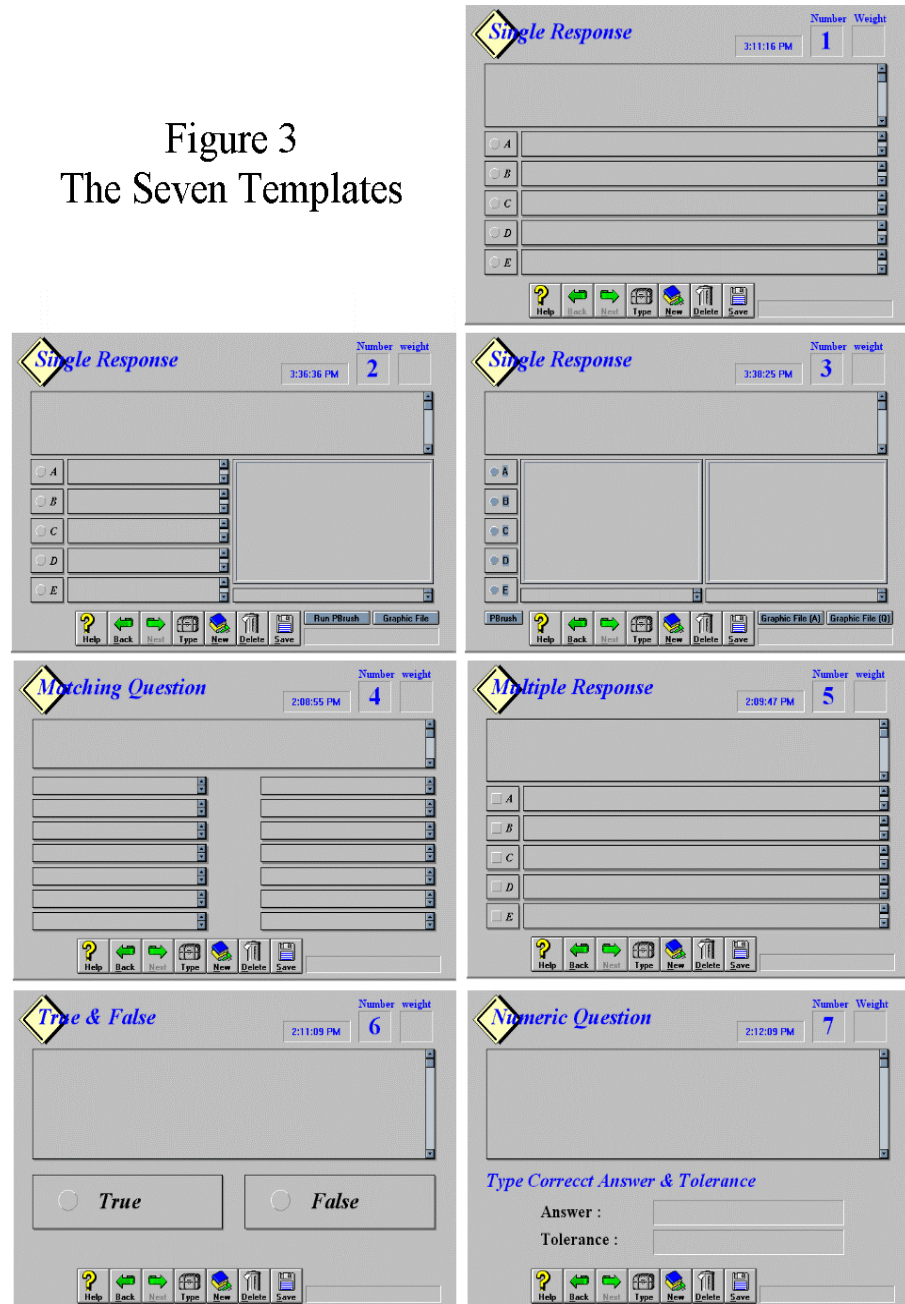
Obtaining and analyzing the results of tests

Students' answers are saved in several files in the directory which the instructor specifies for storing the test results (on the *System Configuration* page). These files can be easily exported to a database, spreadsheet or statistical software to analyze the results. There is one file for each student completing the quiz; it contains the student's name, ID number, the test title, quiz start and end times, the percentage score and the answers that the student gave to each question. This file allows easy student-by-student evaluation, as well as item by item analysis. Students can also see this same information after the test is finished if the instructor has permitted it through the *System Configuration* page.

An additional file written to the directory designated by the instructor on the *System Configuration* page, contains all of the student names and their scores. This file allows the instructor to easily evaluate the performance of the whole class.

4. Classroom Testing

Databases for the Hestenes Force Concept Inventory (FCI) [1] and the Mechanics Baseline Test (BMT) [8] have been created and are available from the authors (since these databases have the correct answers included and since these tests have become defacto national assessment instruments, the authors wish to have direct contact from faculty for security reasons). The creation of these databases led to many alterations in the *Quizzer*. Alterations in existing question templates were
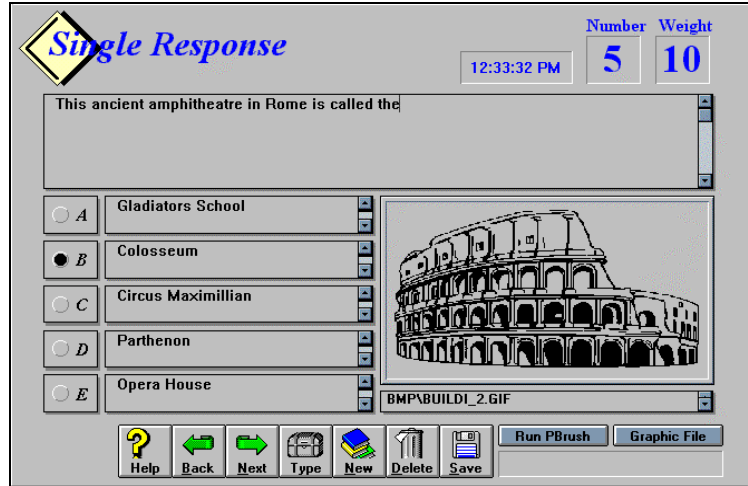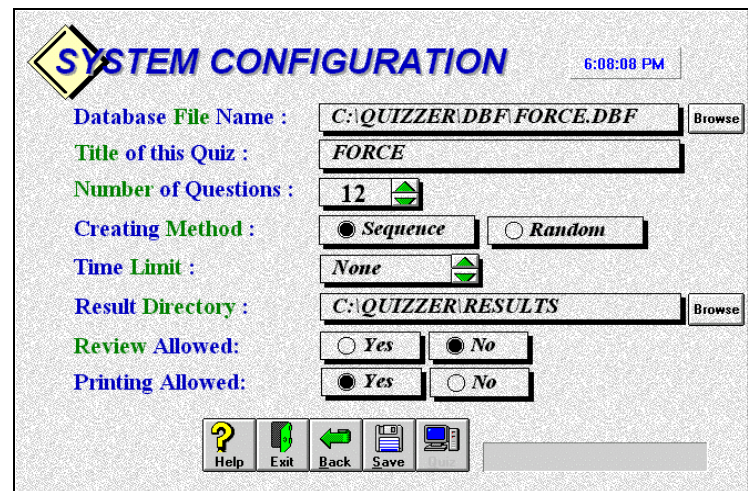

Fig. 4. **A Completed Single Response Question**

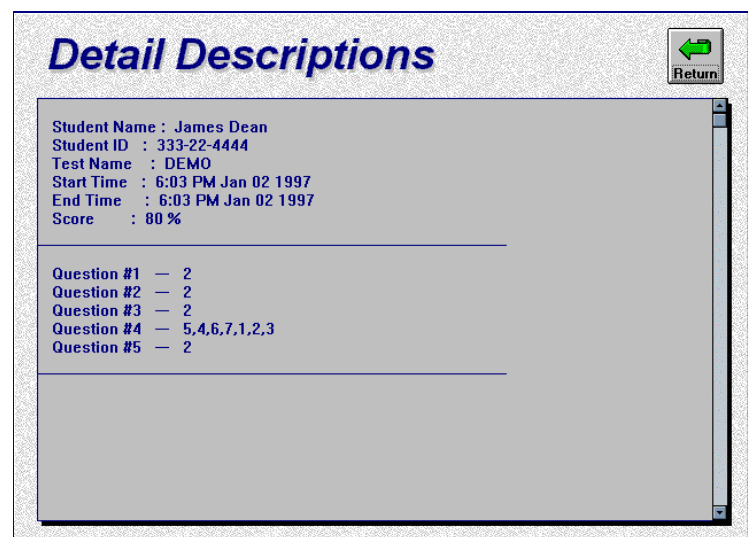Fig. 5. *System Configuration* **for a New Quiz File**

Fig. 6 **Test Result Screen**

made and new templates added. Since these physics-related instruments are often used as pre-tests and post-tests, the instructor option of student review of results was also added.

Both the FCI and the MBT have been given using the *Quizzer* and both went flawlessly. Having the program operate on a network (Novell), made it possible to scrutinize the results as soon as student work was completed.

Another instructor used the package this past semester to deliver his final examination. With only oral instructions, he was able to easily construct and deliver the examination. This use revealed that the scheme used for delivering problems in random order was giving the same random order for all students. This fault has been corrected by using a student's ID as the randomizing seed, thus making each student's order of problems unique. The next version, due shortly, will have the ability to trace back from the file of answers to individual problems. That is, now that the randomizer is operating uniquely for each student, it is currently impossible to know the order of the questions that the student saw. Thus, it is impossible to relate the answers in the student result files to individual problems. This problem is being solved, however.

One thing that was noticed during use in class was that the students seemed to take a little longer to complete their quizzes than if they had been given out in hard copy. This result, which was noticed during the first time students used the *Quizzer*, might be explained by the caution that they exhibited because of operating in new environment.

5. Conclusion

We have designed and implemented a network-based, multimedia testing tool for authoring and delivering electronic assessment instruments. We have used this package in the classroom and compared it with traditional paper-based tests. This package includes the *Quizzer* program, the *Quiz Database Handler*, a user manual, a demo database file, and the FCI and BMT database files. This package is available to potential users as a self extracting file at the ASU CIEE web page,[1] through a no-cost registration process.

Quizzes are easily constructed, updated or built from large test item databases by using the *Quizzer*. The randomization of questions, the use of passwords and other security measures dramatically reduces opportunities for cheating. The ability to change questions easily is another plus, as is the possibility of using color graphics and multimedia to present questions. The most common use of computerized testing tool is for quizzes, tests and self-evaluation exercises, but it can be used for information gathering, screening, diagnosis, and polling.

The current version of *Quizzer* can be used to deliver a test/quiz via standalone computers using the hard disk or floppy disks or from a network server via a LAN. For further use, we are developing a WWW-based version of our computerized testing tool for easy and wide distribution through the Web. ToolBook II™ includes a limited capability of converting ToolBook™ programs for distribution through the Web. Delivering a testing program on the

---

[1] http://www.eas.asu.edu/~asufc/ciee/ciee.html

Web could be used for distance learning with improved accessibility through the Internet. Users can take their tests or sessions by a Web browser, without the need to have any *Quizzer* program.

References

[1] Hestenes, D., M. Wells, G. Swackhamer, "Force Concept Inventory," **The Physics Teacher 30**, 141 (1992).

[2] Milland, J & J. A. Arter, "Issues in Item banking", **Journal of Educational Measures 21**, 315 (1984).

[3] Hubbard, W. H, & R. D. Murphy, " EXAM and QUIZ Questions with Multimedia Responses", Proceedings 1996 ASEE Annual Conference Proceedings, Washington, D.C. (1996).

[4] Oakley, B "The Virtual Classroom: At the Cutting Edge of Higher Education", Proceedings Frontiers in Education'96, Salt Lake City (November 1996).

[5] Little, D. L., W. H. Hannum and G. B. Stuck, **Computers and Effective Instruction - Using Computers and Software in the Classroom**, Longman Inc. (1989).

[6] Multimedia ToolBook™ Version 3.0, Multimedia authoring system for Windows™, Asymetrix Corporation, Bellevue, WA.

[7] Windows™, Microsoft Corporation, Redmond, WA.

[8] Hestenes, D., and M. Wells, "A Mechanics Baseline Test," **The Physics Teacher 30**, 159 (1992).

Biographical Information

IL-HONG JUNG received his BS in Industrial Engineering at SungKyunKwan University in 1986. He earned his MS in Computer Science and Engineering at Arizona State University in 1993, and currently working for his Ph.D. His interests are in Scientific Visualization, Multi-resolution Analysis, Multimedia Education & Assessment Tool.

HOSOON KU completed his BS and MS in Electronic Communication Engineering at Hanyang University in 1985 and 1987 respectively. He has worked as a Research Engineer at Agency for Defense Development in South Korea for 4 years. He is currently Ph.D. candidate in Electrical Engineering at Arizona State University. His interests are in Computer Communication, Network Management, and Multimedia Communication Systems.

DON L. EVANS is the Director of the Center for Innovation in Engineering Education and a Professor of Engineering in the Mechanical & Aerospace Engineering Department at Arizona State University. He completed his BS ('62) at the University of Cincinnati, and Ph.D. ('67) at Northwestern University in Mechanical Engineering. Since then he has taught a wide variety of courses in Engineering at Arizona State University. He is an active member of ASEE, and has served as Division Chair, Program Chair, and Executive Committee Member in the Freshmen Program Division. His principal areas of interest are Engineering Education Improvement, Engineering Design, Energy Studies, System Simulation, Thermodynamics, Heat Transfer, and Fluid Mechanics.