Formative Quizzes and the World Wide Web

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Abstract

The use of quizzes delivered and marked by computers is a long standing well tried technique for helping people learn. This paper gives the rationale for, design of, and experience with, a system to deliver and mark formative quizzes using the World Wide Web (WWW). The WWW solves many of the logistic and delivery problems associated with computer delivered quizzes, and makes them easily accessible to a large number of people.

The paper discusses the design of a WWW system to deliver quizzes to students. It outlines the advantages and potential of the WWW for this task and discusses problems and trade-offs compared with other approaches. It reports on our experience with giving quizzes using a system at the City University of Hong Kong.

Creating questions is a time consuming, difficult task. It is hoped that the quiz system will provide a mechanism for question authors to share questions, thereby spreading the load of question creation and development.

Keywords

quiz, WWW, assessment

1. Quizzes and the Learning Environment

In this paper the term quiz means a set of questions to which a person gives a syntactically simple response. Although the response is simple the questions can require a high level of cognitive processing to answer correctly and so quizzes can be used for many purposes ranging from entertainment questionnaires to formal examinations. Within a learning environment, Jacobs & Chase (1992) say quizzes can be used for:

- grading student's performance;

- giving instructors feedback on how their courses are performing;

- helping students learn; and

- motivating students to study.

The City University Quiz (CUQuiz) system's main purposes are the last three. However, given the appropriate administrative arrangements, it can be used for summative evaluation. A demonstration site of CUQuiz can be reached at http://kcox.cs.cityu.edu.hk/quiztest

A quiz system enables instructors to set quizzes to test student understanding at various levels, to monitor the overall performance of a class, and to see which students are having difficulty with course material. Assessment of students has a major impact on how and what students learn (Ramsden 1985) and through the judicious use of formative quizzes an instructor can direct students towards the course and learning goals. Good responsive feedback from quizzes is highly motivating as it helps students discover what it is they know.

The easiest to set quizzes are those that involve the remembering of facts, terms, concepts, definitions or principles. Most quizzes are of this form and have been popularised by TV game shows and board games and so the use of quizzes is often seen as synonymous with testing of knowledge in Bloom's (1956) taxonomy of cognitive levels. However, with careful design, they can be used to test all the cognitive levels of knowledge, comprehension, application, analysis, synthesis and evaluation (Jacobs & Chase, 1992; Cox & Clark (in preparation)).

2. Students' Requirements of a Quiz Delivery System

Given that quizzes can be a useful tool in a learning environment what is it that students need from a quiz delivery system? The requirements are:

- the material tested is appropriate to the course

- the timing of the quiz fits in with learning progress

- the feedback from the quiz should be rapid

- the quiz delivery should fit in with the work environment of the student

- students should have easy access to other sources of information and other resources at the time of doing the quiz

The CUQuiz system cannot influence the first requirement, but helps meet all the others.

Because quizzes can be made available to students, whenever an instructor desires, and because access to quizzes is 24 hours each day, everyday of the week, students can take quizzes when convenient.

The quizzes are marked by computer and feedback is immediate. When students have completed a quiz they can get back the overall results of all other students on a quiz and compare themselves with the performance of others.

The quiz delivery system should be part of the work environment of the student. The computer attached to a network is today's student work environment (Cox, 1994) and CUQuiz is integrated with that environment.

Quizzes are not a teaching device and they do not attempt to give students new information. Rather they are a tool that help students understand how much they know. However, once students discover they do not understand something they should have access to other resources to help them discover that information. CUQuiz, because it is part of, and integrated with, the World Wide Web (WWW), gives students access to material through on-line course material, and to people through electronic mail. For example, one set of quizzes are part of the on-line material available to students for a module on programming and data structures. The home page for this module can be seen at http://kcox.cityu.edu.hk/cs0365.

3. Instructors' Requirements

Instructors' requirements for a quiz system are:

- ease of use;

- easy entry of questions;

- rapid quiz preparation;

- ability to find out how students are performing;

- easy ways of communicating with students; and

- ways of checking the reliability of the quiz.

Creating good questions is difficult and at present CUQuiz does not help create questions. However, once the material is available then entering questions and creating quizzes is simple, quick and easy. A design goal of the system was to make quiz entry and maintenance available through the WWW. To enter a new question an instructor fills out a form. This is simple, easy to do and fast. After questions have been entered then the instructor creates a quiz by putting together a set of questions.

The CUQuiz reporting system enables an instructor to monitor closely the performance of a group of students. Students who are not doing quizzes, or who are having difficulty doing quizzes, can be easily contacted through the Email.

Although the validity of quizzes cannot be checked with CUQuiz the internal reliability is checked. If we assume that the first attempt a student makes at a quiz is an indication of their knowledge and understanding, then we would expect students who answer questions well on many quizzes in a subject area, will have a better understanding of the course material. We can use these relative rankings of students as a check on the internal reliability of questions by calculating the discrimination index of a question. Questions on which good students do poorly may be poor questions. Questions that distinguish between students who understand and those who do not understand are good discriminators.

4. Administrative Needs of a Quiz System

A quiz system should be inexpensive, cost little to maintain, run on standard hardware and software and require little clerical effort to run. One of the objectives of the quiz system was to create a system that had these characteristics. This has been achieved by leaving almost all the administration and control of quizzes with the people who create a quiz and to decentralise the servers on which quizzes are run. Any lecturer or course provider can easily set up their own quiz system.

An administrative unit that decides to use the quiz system can obtain a copy from the authors and install it on any networked PC running Microsoft Windows™ and Windows httpd (available from http://www.city.net/win-httpd/). The main screens of the quiz system can be altered with any html editor and so tailor the screens to an organisation.

5. Why use the WWW?

Quizzes are a versatile testing tool. They can be delivered on paper, given in class or given as homework. Computerised quizzes can be delivered on an institutional central computer, on a

proprietary network or on a standalone machine. We have chosen to deliver them on the WWW to solve several technical, organisational and logistic problems.

The main problem with paper quizzes is the logistics associated with marking and giving feedback to students. Paper is convenient, cheap, flexible, requires no special equipment and is easily adapted. Paper is probably the best way to give quizzes to students. It is unfortunate that it is hard to record and mark paper quizzes. Machine marking solves some problems but it is difficult to do easily and the feedback to students is slow. Students can be given the answers to quizzes at the same time as they receive the quiz and asked not to look at the answers before attempting the quiz. This solves the speed of feedback problem, but students have to be well disciplined and it is difficult for the lecturer to obtain the student's responses. Paper has advantages for delivery but disadvantages for marking and providing information to the lecturer.

Putting quizzes on computers solves the student feedback problem but introduces problems of distribution and access. Using an institutional computing network solves the problems of distribution and collecting of student responses but introduces problems of student access and availability. Often students have to work on special workstations or terminals, they cannot work from home and have to make special bookings to use the machines. Software and hardware require special administrative people for maintenance and organisation and often there are substantial software costs.

The WWW solves most of the problems associated with institutional computing and keeps the advantages of using a computer. Access is available on any workstation that can access the WWW. This means that in an institution almost all workstations can be used and students home machines can also be used. We can expect, in the future, all students to be connected to the WWW. As previously mentioned, administration of the quizzes rests with the quiz originator and is low cost.

The WWW is almost as convenient as a piece of paper. As more of a student's time is spent using computers instead of using paper, so a quiz on the WWW becomes more convenient. When we add in the communications advantages and the access to other material then having the quiz on the WWW becomes even more attractive.

A final advantage, which we are exploring, is the ability of students to create their own quizzes and to get other students to try the quizzes. This together with the ability to send messages directly to the quiz creator gives another means of students to communicate with each other about the subject material. We believe that between student communication is an important part of the learning process and methods of fostering this in appropriate ways should help students.

6.   Design Guidelines used in Developing the City University Quiz system

The objectives for the system are outlined above. From these, and from our own knowledge of creating information systems, we developed a set of guiding principles to help us develop the system. When a decision had to be made on some part of the system these ideas were used to help resolve and decide on what action to take.

- the system is mainly for formative assessment and security is not critical

- the system is for testing and reporting results, not for delivering instruction

- the system should be self contained

- the interface should be consistent

- development is to be done by iterative prototyping

- the system should be general - i.e. it should run on most students hardware

- we should use existing software wherever possible

- we need a system that makes it easy for people to share their work

- we should give information to people rather than hide it

- there should be owners of quizzes and questions, but anyone can be a quiz and question author

- the structure of the system should be built around questions

- the system should be easy for students to use

- it should be easy for anyone to enter questions or quizzes

- the system should be widely available to many people

- the system should be maintained from client computers

- the system should allow multiple quiz databases to exist on any server

- the system should foster communication between participants

In large part we were able to follow these guidelines and they were helpful in our design choices. Perhaps the most important guideline was trying to make the system as open as possible. That is, we wanted the system to be controlled by the quiz creators and we wanted the student users to be able to get information relevant to them.

7. Limitations of a WWW delivery mechanism

The current system has limitations. Most of these are limitations caused by the limitations of WWW browsers and the way the system has to operate. For example, we were unable to implement hidden multiple choice questions where choices are presented one by one to the student after they answer true or false on each choice. This is not practical at present because to get the next question it would be necessary to return to the server as any operation that requires machine intelligence requires the system to return to the server. This is impractical for these systems as the system does not have a rapid enough reaction and, for all practical purposes, operates in a batch mode. That is, a form is filled out then sent to the server which processes it and sends another form. This may be overcome with the next version of WWW browsers that incorporate aplets that can be downloaded to the client machines. This would allow greater interactivity and permit more complex client operations.

8. Implementation Issues

The system was implemented over the summer vacation by three first year student programmers using Visual Basic^{TM}. These students had completed two semesters of programming and data structures using C^{TM}. They had never seen Visual Basic or html documents or used the WWW. The basic functionality was specified by the authors who guided its implementation.

The system proved relatively easy to implement. This was because the way it had to be constructed lent itself to modularity. Each function, each generated document, is a separate program. Because of the nature of the WWW there is no thread of interaction kept for a user. That is, each message that

comes to the system is standalone. The server keeps no state information and it is not necessary to keep track of user sessions. Both these make for a clean, simple modular implementation and structure. The interfaces between components is defined by the structure of the database and by the content of messages sent from the user. In overall structure the system is very much a pure object implementation.

9. Types of questions

At the time of writing the system handles two types of questions in two modes. The question types are

- multiple choice

- fill in the blank or number

The two modes are quiz mode and questionnaire mode. In questionnaire mode any answer the user gives to a question is treated by the system as being correct. This allows the system to be used to deliver and administer questionnaires as well as quizzes.

The fill in the blank allows wild card characters in the possible answers but otherwise it is a simple character matching of text to the answer.

At present diagrams are difficult to enter. This is a problem because it is messy to transfer diagram files to a server computer from a client question maker's computer. It is a logistics problem rather than a technical constraint.

10. Functions Available

The system meets the design goals stated above. Authors start by identifying themselves then they create questions. Questions can be viewed and new questions entered. As a question is entered it is shown to the author in the same way a student will view it. Questions are grouped into categories. This is primarily for searching purposes and to reduce the number of questions an author might review when creating a new question.

After all the questions are created the author combines them into a quiz. The questions may be rearranged and adjusted within a quiz. Quizzes are arranged into groups for the students. Typically an author will create a group of quizzes for a particular purpose, such as testing a programming language, or reviewing a course.

Questions can be sent between servers as text files. That is, questions can be transmitted as HTML pages, saved on a client, then loaded to another server. This makes it easy to share and distribute questions.

Various reports are available to authors. They can get a summary of all the students who have tried a particular group of quizzes. Within the group they see how many quizzes each student has tried and the date attempted. The author can send messages to a student or to all students in the group.

A particular quiz can be examined in more detail. The distribution of the answers to the first attempt at a quiz are given. Indicators of question difficulty and ability to discriminate are shown. Statistics are shown that indicate questions which may have problems, such as the wrong correct answer or poor discriminators. For fill in the blank questions, all the answers given by students can be displayed.

The details for each student can be displayed. The author can see what answers any student has given to any question. This same report is available to students, but they can only see their own results. When a student has finished a quiz, they can get a summary report on the whole quiz to see how everyone else has done and so compare the overall results to their own answers. Students can send messages to the quiz owner when answering questions or when reviewing results.

When a student takes a quiz they can keep taking it until all their answers are correct. When they retake a quiz only the questions not previously answered correctly are reshown.

11. The future

The system can be extended in different ways. When extensions are made they must not make the system too complex as one of the current advantages is its simplicity. The main extensions envisaged are:

- new types of questions

- use of aplets to make question interaction more expressive

- use as summative assessment

- new statistics to help authors create better quizzes

- integration with other learning tools

The new question types are computer generated questions, matching multiple choice and hidden multiple choice. Hidden multiple choice require the use of aplets or programs transmitted with the quizzes. This is the next feature that the Netscape browser is likely to possess.

Aplets will also permit the questions to become more intelligent in other ways and will allow the better use of graphics and simulation of problem situations so that student responses can alter the questions.

The system, at the moment, can be used for summative assessment. Quizzes can be timed and released at a given time. However, for multiple choice there is another, perhaps better, method of marking (Pollard, 1989) that enables students to indicate what they know. This is not appropriate for formative assessment but is a better system when multiple choice quizzes are used as a summative tool.

There are certain patterns in quiz formation that a computer can detect. These patterns allow students to guess the author's intent. For example, an author may make the majority of correct answers the last answer in the selections or the answer in a fill in the blank may be given in the question or in a neighbouring question. An author should be able to request the system to check for these obvious give-aways.

The quiz system is one learning tool for students. It is envisaged that the WWW can deliver and provide other tools, such as personal tutors. The quiz system could be integrated with these other tools to give an integrated educational environment for students.

12. Summary

This paper does not describe any new conceptual initiative in teaching. Rather it is an engineering paper describing a practical solution to a problem worth solving. The WWW has the potential to

deliver information to students in an economic, convenient manner. The CUQuiz system is one example of what will become an important method of communication between students and teachers.

13. References

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