Multiple Choice Quiz in a Web Assisted Teaching Environment

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ABSTRACT

Web Based and Web Assisted Teaching provide new tools in education. In a web context, not only new teaching resources can be invented and exploited, but also well known and long used teaching resources can be used more effectively and in a simpler way. The paper is based on a project for creating, updating, distributing, an reusing Electronic Teaching Resources (of which multiple choice quiz are only one example) funded by the Department of Mathematics and by the Faculty of Science of the University of Rome "La Sapienza".

1. Introduction

Web Based and Web Assisted Teaching provide new tools in education. In a web context, not only new teaching resources can be invented and exploited, but also well known and long used teaching resources can be used more effectively and in a simpler way. In this paper we want to show how the production, usage and sharing of multiple choice quiz in a web context allows substantially new and far reaching applications. The paper is based on a project for creating, updating, distributing, and reusing Electronic Teaching Resources (of which multiple choice quiz are only one example) funded by the Department of Mathematics and by the Faculty of Science of the University of Rome "La Sapienza" [1].

2. A Web Based System for producing, archiving, and using Multiple Choice Quiz

We describe a system which has been experimented in some courses of Mathematics of the Faculty of Science at the University of Rome "La Sapienza" (*Informatica*: Analisi 1, Matematica discreta: algebra. *Biologia:* Istituzioni di matematiche. *Farmacia:* Istituzioni di Matematiche). The system is still experimental; many of the services explained below have been implemented with a poor interface. The bulk of the discussion can be applied with minor changes to other Electronic Teaching Resources (ETRs for brevity). We have decided to limit ourselves to Multiple Choice Quiz (MCQs) for clarity. In order to build this system many problems had to be considered:

1. *Formats and interfaces for producing and modifying multiple choice quiz.* A flexible but precise definition of formats is fundamental for automatic archiving and easy reusing. Easy interfaces are needed for producing MCQs without worring about formats. Authors can choose either to produce MCQs online or offline and upload them later to the system.

2. *Permissions.* To share MCQs in a web environment particular care must be paid to set permissions. Each MCQ has an author (which could also be a pool of people, like all

teachers of a given course). Authors are allowded to change MCQ's default permissions. For example an author may decide to show a given MCQ only to other teachers and allow them to use it for their tests, but he may also decide that it cannot be inserted into any on-line teaching paths prepared by other people. An author can also decide if and when students are allowded to see the quiz, and let them use it for personal studying and for auto evaluation.

3. *Archiving resources.* MCQs are archived in a system of internet connected Data Bases. Great care has been paid to prepare the indexes and a system of classification for MCQs. Classifications schemes are configurable and classification is allowded to change. Different views on the same material is explicitely allowded.

4. *Accessing resources.* Of course web access is crucial for sharing and reusing MCQs. This does not mean however that the most of the users access MCQs through the web. People with suitable privileges (authors and teachers) can ask the system to print a selection of MCQs, to prepare a test or to collect them in a searcheble CDRom (automatically produced by the system). For each MCQ, different views are possible. For example a text-only quiz has a method to convert it into an internally linked HTML page and a method to convert it into an internally linked pdf file. A MCQ with mathematical formulas has a method to convert it into a linked pdf file and a method to convert it into a ML file. Moreover MCQs can be linked to others ETRs into a learning path.

5. *Reusing resources.* A database of well archived MCQs in well structured format is a rich reservoir for teaching applications. It gives many didactical opportunities, for example;

   (a) Teachers can use the database to easly prepare MCQ based tests. (b) The system can use the database to automatically prepare MCQ based tests for autoevaluation.

   (b) Teachers can immediatly put online solutions and comments to their tests in hyperlinked documents.

   (c) Teachers can easly aggregate MCQs in learning path. For example for filling the gaps in prerequisites. Many services provided by the system have been explicitely developed in order to help cooperative work on such projects. For example high school teachers have been asked to help our Department to prepare MCQ based learning paths to help first year students to brush up their math knowledge.

The system provides many web accessible methods for using the MCQs (see below for further information). For example methods for preparing and correcting tests and methods for appending notes to a MCQ. These services can easly be integrated with an archive of students to keep automatic track of students learning path. This allows for example:

1. *To prepare ad hoc learning paths on the basis of the results of a test.* This is a very difficult goal to be attained in full generality, but also small steps towards it can produce very interesting results. For example appending to each MCQ of a test a statistical note in which is recorded the percentage of students which have chosen each answer gives teachers immediate feedback on what has been understood properly and

what has not, and give students the opportunity to compare their performance with that of the others, and focus their efforts to studying what other students know well but they don't.

2. To use on line teaching resources *to stimulate students to active partecipation*, by rewarding students for appending notes and comments to MCQs. This may be used to understand better students' difficulties, rewrite comments, prepare new MCQs based on students difficulties, and so on.

3. Ob jects, Methods and Formats

MCQs can conveniently be thought of as objects, to which given methods apply. In this section we say something more about the internal structure of our objects and what can be done with them.

3.1 Objects and Formats

For using and sharing conveniently a MCQ in a web environment, an agreement about formats must be found. Formats may conveniently be specified as xml files, even if authors may never become aware of it. Actually, MCQs are not xml files but entries in a database and a certain bunch of files ready for delivering (e.g. html and/or pdf files). However it is much easier to describe them as if they were xml files. To allow different kinds of MCQs, different formats must be considered. One for text only MCQs, one for MCQs containing mathematical formulas, one for MCQs containing chemical formulas, one for MCQs with 2D graphics, one for MCQs with 3D graphics. This is a very coarse classification. A finer one is based on the software used to produce them. We used LATEXwith various packages to produce all our examples. This system is incredibly powerful and flexible.

A MCQ contains the following information (not all required).

1. *General information* about authors, date of production, privileges, keywords.

2. *A question and an array of answers with comments and weight to each answer* . Comments to wrong answers are of great importance since they allow teachers to give different explanations of the same thing in a way dependent on student's mistakes. These explanations can therefore be much more effective. A teacher may choose not to comment a MCQ. He may ask students to put comments to each answer or to complete a track of solution. Student's contributions appear as appended notes, unless the teacher decide to enclose them in the main body of the MCQ. Moreover each text has the possibility to be enriched in a multilingual context. This can be exploited to provide material for classes in foreign languages and for students which want to study abroad.

3. *Classification.* A MCQ is classified by its author, possibly in a coarse way. Later, the author or someone else with suitable privileges may decide for a finer classification within a particular teaching path. The same MCQ can be used in different contexts (if the author allows this) and get accordingly different classifications.

4. *Usage statistics.* Each time a MCQ is used in a test (either prepared by the teacher or by the system) the MCQ usage profile is updated (to each answer is appendend the percentage of people which have chosen that answer). This increases its teaching value: teachers have an objective method to measure its difficulty; students get a measure of their knowledge compared to that needed to pass an exam.

5. *Notes.* Many kind of notes can be appended to a MCQ. Requests for further explanation, proposals of solution, translations, pointers to other resources, comments on the difficulty. Each of these notes may be inserted in the body of the MCQ if its author wants it.

6. *Interfaces.* A list of ETRs which can be extracted by a given MCQ and a list of ETRs types to which it can be appended or connected to. For example

   (a) In an MCQ in which the question is "which of the following is true?", each answer can be extracted and used in other MCQs of the same kind.

   (b) An MCQ can be appended to a learning path, either as a suggested exercise or as a locker to be opened (maybe together with other lockers) to proceed further in the learning path.

4. Methods

In this subsection we collect some methods needed to create, use and modify a quiz and to assemble, prepare and correct a test. All these methods are web accessible with suitable authorization.

4.1 Quiz methods

1. *Creating and modifying a MCQ.* Different web interfaces are provided, depending on the type of MCQ being produced.

2. *Appending an attribute to an already existing MCQ* (classification, translation, comment, statistical element). Attributes may be set by the author or directly by the system.

3. *Insert a MCQ into a database.*

4. *Transform a quiz into a suitable displaying format* (for example transform a text-only MCQ into a html document; transform a MCQ with mathematical formulas into a pdf document).

4.2 Test methods

1. *Selecting an array of MCQs for a test* by searching in the Data Base, modifying some of the selected MCQs and possibly writing new ones (which will automatically be added to the Database at the end of the process).

2. *Grouping MCQs in homogeneus clusters.* In this way an array of clusters of MCQs can be prepared. To make the test the system picks randomly a MCQ in each cluster and then shuffle the order of the selected MCQs and the order of the answers in each MCQ and it prints a different copy of the test for each student.

3. *Preparing or modifying the valuation grid for a test,* i.e. weight each answer of each MCQ of the test. This can be changed at any time if results do not satisfy the teacher or if some mistakes or ambiguities are discovered.

4. *Acquiring the answers of students to the test,* the student id and the test code (which identifies the shuffling made to prepare the copy of the test answered by the student) either by hand or by using an optical reader or directly by computer.

5. *Correcting tests on the basis of the valuation grid,* publishing on-line and on-paper results of a test and extracting statistical elements.

6. After the exam the teacher can ask the system to *put on line the test* in the form of a hyper linked document, with solutions and comments. Students can read solutions and comments few hours after having taken the test. This has provided to be didactically valuable. Moreover students can send notes if some answer are not clear or if they find errors. This makes a test still more effective.

7. The results of a test can be stored in an archive and used to prepare further tests. For example, in one of the courses we taught, (Matematica Discreta: algebra) we based three mid term exams on multiple choice quiz and the exam was prepared by asking to each student only questions on topics he did not understand enough. The same idea can be used for implementing computer driven autoevaluation.

5. Related Works

Many projects have been designed to explout the new perspective that WEB offers to didactics, and in particular to Mathematicas. We want to mention only a few that we consider particularly related to our project.

1. The IEEE Learning Technology Standards Committee (LTSC) aims at giving a general metadata definition for Learning Objects [2]. The definition and standardization process is currently at its 6th draft of the DTD.
2. Two projects [3,4] that are now exploiting the concepts of ETRs: WebTeach at the Applied Mathemathics Dept. of Florence University and the EduML project at Vancouver. Both projects are focused on the integration of several tools (Latex formulae, gnuplot plots, MCQs, programming code examples, picture annotations ...) in a easy cooperative teaching environment, and use the WikiWeb [5] methaphore (all users can cooperatively edit the documents in the Web) as a background cooperation model. Like our project, the EduML project is currently defining a DTD for the standardization of such kind of mixed documents.

6. Conclusions

The system described here can be greatly expanded along the lines we have sketched above: it would even be possible to build an international bank of MCQs (ETRs in general). At the moment we are working for sharing this system with high school teachers. This seems to be interesting for many reasons, for example:

1. high school students can get a clearer picture about university studies;

2. high school teachers can use the system to prepare MCQ based tests for their students and, at the meantime, their MCQs can be used to help students to brush up their math knowledge;
3. university teachers can interact better with high school teachers and students to reduce the gap between what is assumed to be known and what is known by first year students.

References

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