Creating Online Tests with eqExam

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1   Introduction

Have you ever wanted a simple way of creating an online test or quiz for your students? This paper describes one approach that I have taken that uses a LaTeX to PDF workflow.

The method I will describe to you requires that you have (1) a TeX System and some experience using it; (2) experience in downloading and properly installing the LaTeX packages necessary for my approach to work;[1] (3) a method of creating a PDF document (using the Adobe Distiller 5.0 or later, or one of the applications pdftex or dvipdfm); (4) access to a Microsoft Windows server running Internet Information Server (IIS), version 4.0 or greater; and, of course, (5) a willingness to try something new.

2   The eqExam Package

The eqExam package is a public version of the personal exam package I have used for years as mathematics professor at the University of Akron. I enhanced my personal package so that it could not only handle the creation of traditional paper tests, quizzes and homework assignments, but supports online testing as well. The document format of the online exam is Adobe's Portable Document Format (PDF), as opposed to an `html` page.

The eqExam package is a stand-alone LaTeX package for creating nice looking paper exams; however, to create an online/interactive exam, additional LaTeX packages are needed. These packages are

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[1] Download from CTAN, the Comprehensive TeX Archive Network at `http://www.ctan.org/`, for example.

- The `hyperref` package:[2] A standard package for online work. This package automatically creates hypertext links from standard LaTeX cross-reference commands.

- The **AcroTeX eDucation Bundle**: A collection of LaTeX packages which I wrote for creating online, interactive quizzes. This package is available from CTAN[3], most current version can be downloaded from the package homepage.[4]

- `everyshi`:[5] A technical package required only if you use pdftex to create a PDF document.

2.1   General Features

The eqExam package provides the usual features for creating tests, quizzes and homeworks. With it, you can create multiple choice, True/False, short fill-in the blank and extended response questions.

When the exam is first written, the instructor types in the questions in a specified format, and optionally, types in the answers, or solutions.

The exam can be published in several different ways:

1. "Test mode": The solutions and answers do not appear in the document. The document has the traditional look of an exam. This is the `nosolutions` option of the eqExam package.

2. "Answer key mode": In this mode, the solutions and answers appear along with the questions. This mode is useful for publishing an answer key for the instructor, or distributing the answers to the test after the test period is over. This is the `answerkey` option.

3. "Solutions at end mode": In this mode, the questions are listed first, and the solutions are listed at the end of the document. Useful for publishing a review document, the students can first solve the problems, then they can look at the instructor's solutions. This is the default behavior of the eqExam package.

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[2]Available from CTAN `macros/latex/contrib/hyperref`
[3]`macros/latex/contrib/webeq/`
[4]`http://www.math.uakron.edu/~dpstory/webeq.html`
[5]Available from CTAN: `macros/latex/contrib/ms`

Below is a simple example of an eqExam document, which includes the different types of questions that can be posed. Some of the discussion that follows references this example, and Figures 1, 2, and 3 show this document as it would appear at different steps of the grading workflow.

```
\documentclass[12pt]{article}
% The preamble, here we input the eqExam package with some options
\usepackage[forpaper,pointsonboth,useforms,nosolutions]{eqexam}

% Specify some identification info.
\title[T1]{Test 1}    \author{D. P. Story}
\subject{US History} \date{Spring \the\year}

\begin{document}\maketitle

% Formal beginning of the exam.
\begin{exam}{Part1}
\begin{instructions}
Solve each of the problems without error. If you make an error,
points will be subtracted from your total score.
\end{instructions}

% This is a short fill-in question with solution.
\begin{problem}[5]
The first president of the United States is \fillin{2in}{George
Washington}.
\begin{solution}
He couldn't tell a lie, George Washington.
\end{solution}
\end{problem}

% Multi-part question of True/False questions
\begin{problem*}[4ea]
\textit{True} or \textit{False}.
\begin{parts}
    \item \TF{F} Thomas Jefferson was the second president of the United States.
    \item \TF{T} John Adams was the first vice-president of the United States.
\end{parts}
\end{problem*}

% A question that requires a written response; 3 inches of vertical
% space is provided for the solution.
\begin{problem}[7]
Write a brief history of the United States.
\begin{solution}[3in]
See Chapter 2 of text.
\end{solution}
\end{problem}

% A multiple choice question, with solution.
```

```
\begin{problem}[5]
In what year did Columbus sail the ocean blue?
    \begin{answers}{6} % specify tabular with 6 columns
    \bChoices
        \Ans0 1490\eAns \Ans0 1491\eAns \Ans1 1492\eAns \Ans0 1493\eAns
    \eChoices
    \end{answers}
\begin{solution}
    Yes, Columbus sailed the ocean blue in 1492.
\end{solution}
\end{problem}
\end{exam}
\end{document}
```

This sample document contains all the various types of questions that can be posed. Figures 1 and 2 show this sample exam as the student would see it, and as the instructor would see it, the answer key.

Figure 1: Document built in "Test mode"

Figure 2: Document built in "Answer key mode"

The complete documentation for the **eqExam** package as well as sample files can be found at `http://www.math.uakron.edu/~dpstory/eqexam.html`.

2.2 Let's Go Online!

As already mentioned, **eqExam** is a LaTeX package for creating exams, quizzes and homework assignments for paper, but what separates **eqExam** from the other exam packages[6] is its support for PDF.

With regard to PDF, there are several package options, `pdf`, `links`, `online` and `email`, the author can select. Here, we discuss only the latter two. For these options, the

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[6]For example, **exam** by Philip S. Hirschhorn, and **examdesign** by Jason Alexander, both available from CTAN.

`hyperref` package and the **AcroTₑX eDucation Bundle** are required.

When either one of the options `online` or `email` is taken, Acrobat form elements are inserted into the document creation workflow, and the document becomes interactive when viewed as a PDF from within the Adobe Reader: The alternatives of a multiple choice question become radio button fields; for a true/false or short fill-in question, the blank spaces (usually underlined) left to write in the response are changed into text fields designed for input; and for a long response question, the vertical space left for the student to write into becomes a multi-line text field.

It is important to point out that an online exam created by eqExam is not suited for (academic) fields of study that require the student to input special symbols, such as what you would encounter in mathematics or physics, for example. For any type of fill-in question, the response can only take alpha-numeric text as input.[7]

2.2.1 The `online` Option

This option is specified in the preamble of the document, for example

```
\usepackage[online,forpaper,pointsonboth,useforms,nosolutions]{eqexam}
```

As I originally conceived this option, the student can go to a CBT lab,[8] call for the exam to be brought up, and respond to each question at the computer by making multiple choice selections or typing in responses. When finished, the student can print the exam to a lab printer, and hand in the completed exam to the instructor for traditional grading.

Another application of the `online` option is to create online forms that members of a targeted population can fill out online, print and submit it by hand, or by (land) mail. The document created by eqExam does not actually have to be an exam, it can be any series of questions that require a response, such as a teacher evaluation, a questionnaire, or even a survey.

2.2.2 The `email` Option

For the `online` option, the individual must print out the document and submit by hand. A better solution would be to submit electronically, this is the purpose of the `email` option, specified in the preamble as follows:

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[7]Math questions can be posed through multiple choice questions, any fill-in, however, must be text.
[8]Computer Based Testing.

```
\usepackage[email,forpaper,pointsonboth,useforms,nosolutions]{eqexam}
```

This option is the same as `online` except that a submit button is added at the top of the first page. As the name of the option suggests, the **eqExam** submits the form data to a server-side script that, in turn, sends the data as an email attachment to the recipient, whose email address is specified in the form data. It was for this purpose that I wrote a server-side script, called `eqAttach.asp`. This script is distributed along with the **eqExam** package and needs to be installed on a Windows server platform, running Microsoft Internet Information Server (IIS), version 4.0 or greater.

In the preamble of the LaTeX source of an **eqExam** document with the `email` option, the following command is required:

```
\SubmitInfo{http://www.myWebSite/scripts/eqAttach.asp\#FDF}
    {myname@mymailprovider}
```

This command adds the submit button to the top of the first page, and supplies the information needed to submit. The first argument is the **URL** to the server-side script, the second is the email address of the individual to receive the respondent's data. (You can also provide a comma delimited list of email addresses to have multiple recipients.[9])

If you take the sample document listed earlier, include the `email` option and insert the `\SubmitInfo` command, the document is ready to go online! It's as simple as that![10]

Taking the Exam. The student can take the exam in a secure, controlled site, such as a CBT Lab; in this case, the online test can be taken for significant credit. If the site is not controlled, such an online exam or quiz cannot be for major credit.

The student brings up the exam in the browser, answers the questions by selecting alternatives offered in any of the multiple choice questions, and by typing in responses to the fill-in questions. When the student is finished, the student clicks on the "submit" button. If all goes well, the responses are sent off to the server-side script, `eqAttach.asp`. The script creates an email, addresses it to the individual specified by the incoming data, and includes the student's exam responses in the form of an email attachment.

Grading the Exam. Exam results arrive by email to the designated destination, usually an instructor. Some mail clients can be programmed to place emails having certain phrases in the subject into an assigned mail folder. This is what I do. At your convenience, the emails

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[9]For example, one copy to the professor, and one to a graduate student who will grade the exam.
[10]Well, not quite.

can be opened and the attachments saved to a some prepared folder on your computer. (Some email clients can do this automatically, if you can figure out how to do it.)

Before you grade your first exam, go to the folder were the form data for the exam are kept and place a copy of the exam, the PDF version, into this folder.

Figure 3: The Graded Document

At the time of submission, the Adobe Reader gives the form data file a random name, for example, `rad160D7.fdf`, is typical. Double click on one of these `.fdf` files,[11] your Adobe viewer (Adobe Reader or Adobe Acrobat) will start, the exam document will be opened in your viewer, and finally, the form data will populate the exam document. What you'll see at this point is the student's exam with all responses. Grading of the exams can be any of two methods:

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[11]FDF stands for Forms Data Format, this is the format the Adobe Reader uses to transmit form data.

- The instructor can print the document and hand grade. For this, the instructor needs only the Adobe Reader.

- If the instructor has Adobe Acrobat 5.0 or later, the mark up capabilities can be used to grade electronically. The instructor can mark up the exam and includes notes and remarks on the PDF itself. After summing the points and recording the score for that student, the instructor can even send the marked up exam back to the student via email. No paper used at all! Figure 3, on page 8, shows the graded exam using Acrobat markup tools.

Advantages of this Approach. When I wrote eqExam, I wanted a simple "desktop" workflow to the problem of writing and evaluating online exams for credit. Once the server-side script, `eqAttach.asp`, is installed on the server of your school or department, there is nothing more to do server-side other than uploading your online document to your web site. For this workflow, there are no databases to install and to monitor, for example. Everything is done on the instructor's computer: The results arrive by email, they are graded (possibly using Acrobat markup), and the marked up exam is returned to the student (possibly by email).

3   Applications

If you are conversant with LaTeX and have a desire to offer online exams and quizzes to your classes, using eqExam package is a simple, yet elegant approach. Applications of online eqExam are not restricted to exams and quizzes, however, an eqExam document does not actually have to be an exam, it can be any list of questions that require user input.

You can use eqExam to create online forms, questionnaires, teacher evaluations, and sample surveys. One such example is the "TeX/LaTeX Usage Survey" that I published in January, 2005. The survey was written as a demonstration file for the eqExam package and as a service to the TeX community. The survey is ongoing so you can go to

```
http://www.math.uakron.edu/~dpstory/eqExam/tex_survey.pdf
```

and take the survey. A preliminary report on this survey, "Producing a TeX/LaTeX Online Survey with the eqExam Package" is also published in **The PracTeX Journal**.

9