ExamOnline: E-Enabling Extended Answer And Essay Examinations

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Abstract

The authors of the present paper describe ExamOnline, a system specifically developed to e-enable summative essay style examinations delivered in a Higher and Further Education setting. They also discuss the results of two live pilots, undertaken with the same group of students but with two different versions of the system. The system has been specifically designed to support existing examination processes, such as clerical level document-based authoring and distributed assessment by multiple markers. From an educational perspective, the aims are to provide a better and more relevant examination experience for increasingly computer literate student cohorts and to support effective blind marking of on-screen student responses. The authors also seek operational efficiencies in terms of paper-free streamlined administration and marking. The results of two live pilots indicate that the system achieves the objectives in terms of both the student experience and staff perception of fairness in assessment.

Introduction

The vast majority of HE/FE summative examinations are not composed of atomic, closed form assessment units, such as Multiple Choice Questions

(MCQ). Instead, they consist of questions requiring extended responses and essay type answers. Educators dread the marking burden such examinations impose, but they are firmly wedded to the perceived advantages of the assessment instrument in measuring a student's understanding rather than their ability to retain data. For the bulk of UK HE/FE examinations, therefore, there is little imminent likelihood of a mass migration to on-screen automatically marked tests. Nevertheless there are important drivers to move away from paper based tests and towards on-screen assessment.

Not the least of these relates to the quality and relevance of the assessment experience for students when generating extended response or essay answers without recourse to that now ubiquitous tool, a word processor. The increasingly anachronistic constraints imposed by hand written examinations (no cut-and-paste, no formatting, no spell check, etc) bring into question the very fitness for purpose of a script based examination process for an increasingly digital cohort (Prensky, 2001).

Reducing or removing the more undesirable aspects of subjective marking is another driver. Blind marking, easily implementable in an electronic system, is eminently desirable, as is removing the (possibly subconscious) influence on marking of poor (and often illegible) handwriting and, increasingly, poor spelling and grammar.

The move towards on-screen delivery and marking of "traditional" examinations is, potentially at least, problematic. The now familiar issues relating to delivering tests on-screen (Conole, 2005; Sim, Horton, 2005) are potentially magnified in a test where extensive typing is required. Moreover, existing commercial e-assessment platforms are geared towards the delivery of closed form items, automated marking, and item banking, and are not generally modelled on the classical HE/FE examination model. Creating and administering tests on these systems is often the domain of specialist learning technologists. This is in stark contrast to the existing situation with paper-based examinations, where the administration of the examination process (i.e., test paper formatting, photocopying, distribution, marks accumulation and output) is typically in the hands of academic, administrative and clerical staff. Assessment is generally carried out by individuals or teams of academics who literally 'mark' written responses in the answer books.

Background

For the reasons mentioned in the introduction, the team managing the MSc programme in Railway Systems Engineering and Integration (RSEI) at the University of Birmingham have embarked on the production of an end-to-end on-screen examination system specifically tuned to the requirements of the HE/FE summative examination process. They chose a small commercial supplier to adapt well tested software to cope with the new demands.

The RSEI programme is an interdisciplinary postgraduate course. The programme has a strong focus on developing individuals' railway engineering knowledge and their systems integration skills. Many participants are

experienced railway engineers and managers, sponsored by their employers. The taught part of the programme in RSEI is built around eight assessed modules of 15 credits each, four supplementary modules and an integrating dissertation attracting 60 credits, all at the Masters level. An assessed module involves about 30 hours of teaching, 20 hours of tutorials, a major team exercise and some 90 hours of independent study. The assessment of learning is based on class tests, assignments and end of year examinations.

The system described in this paper has initially been used to deliver two class-test type summative examinations to MSc students enrolled on the RSEI programme, during the 2007 spring semester. The system will be rolled out on a wider basis during the remainder of this academic year and into the next. The name of the system is ExamOnline.

The HE / FE Examinations Model

ExamOnline has been specifically developed to e-enable summative essay style examinations delivered in an HE/FE setting. Assumptions for the examination model are as follows.

- Examinations will generally consist of essay / extended response / short answer questions (and possibly a mixture of all three);
- Some questions will require drawings and calculations to be assessed as part of the process;
- Examinations will be invigilated through the physical presence of staff, on University / College premises;
- Examinations will require detailed human marking, often involving multiple markers.

User Requirements for the System

The user requirements that were identified for the e-enabled examination system can be summarised as follows:

- It must be specifically designed to support the prevailing HE/FE examinations model, as outlined above;
- It should be simple to use. Specifically:
    - Present an intuitive and, where possible, familiar interface to students, invigilators, assessors and administrators;
    - Be web-based, with all content presented in a standard web browser, with no client software installation required.
- It should provide an efficient, streamlined examination process, specifically incorporating the following features:
    - Support secure, distributed, on-screen marking by multiple markers;

- Support secure “offline” marking such that markers can download data to laptops for marking “as and when”, and support the subsequent synchronisation of data on upload;
- Support simple, intuitive, document-based test authoring and results output, suitable for use by administrative / clerical staff and, in some cases, academics.

ExamOnline has initially been used to deliver two summative examinations to MSc students during the 2007 spring semester, with further summative examinations to follow shortly. An overview of the system and a description of the key design issues and features are presented in the following sections.

The ExamOnline System

Key aspects of system design are outlined in the following sections. Planned extensions and developments are mentioned in outline only.

Test Authoring

The system has been modelled on the existing examination development process, accepting that most examination papers at advanced level consist of text based questions with occasional graphics. A key part of this is that exam papers are developed as ***documents*** – they not have to be assembled from banks of items. As a matter of course, authors will routinely cut and paste (and possibly modify) existing questions from previous exam papers but, typically they do not maintain a bank of questions in the form that is familiar to proponents of computer-based testing. The tool that they will use for creating examination papers is, of course, a word processor.

For these reasons, the test creation interface for ExamOnline is just that, a simple web-based WYSIWYG (What You See Is What You Get) word processor which supports text formatting, inclusion of graphics and cut and paste from traditional word processor applications, such as Microsoft Word.

The system does not require the creation of individual items, but rather that of examination documents (test papers), into which the persons in charge of exam paper production insert ‘question links’ using the authoring interface (see Figure 1). When the paper is delivered (i.e. when the on-screen examination takes place) the students will click on these links to answer individual questions. The entire process is geared towards the existing skills of administrative staff in producing word-processed documents.

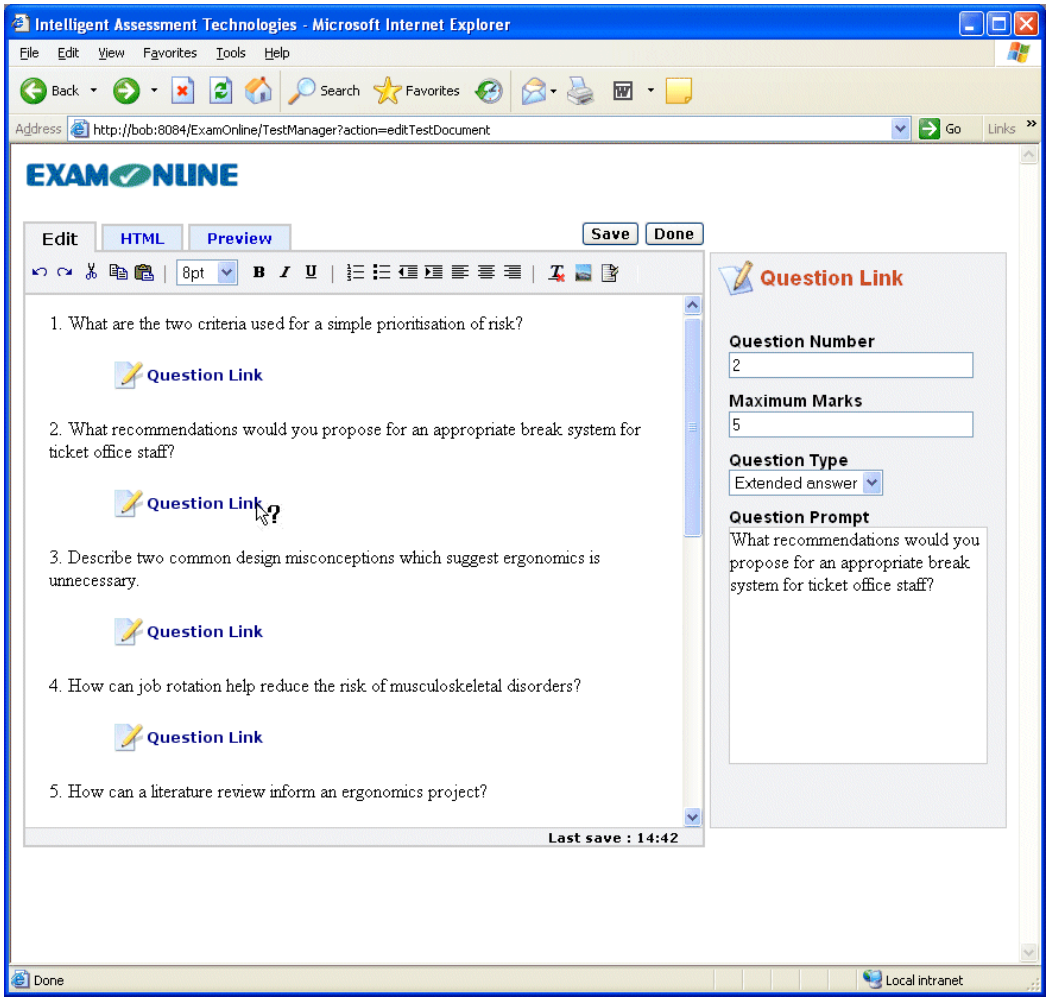

Figure 1: Screenshot of test authoring interface

Administering an Examination

The system is based on the well-known model of an invigilated examination, with the invigilator in the same room as the students sitting the examination. The invigilator logs in to ExamOnline using a PC, or another web-enabled device, in the exam room itself, and the system provides a simple point and click interface for the invigilator to select the examination paper. The next step is to open a login session for the examination and to specify a class login. The class login is released to the students, most likely on an OHP or data projector. The candidates are then able to login to the system and to proceed as far as a holding page, which gives instructions on the test. When ready, the invigilator will open the test session proper, specifying the duration of the session and, at the same time, defines a class password for it. When this is released to the students, they can begin the examination. The diagram in Figure 2 illustrates this process.

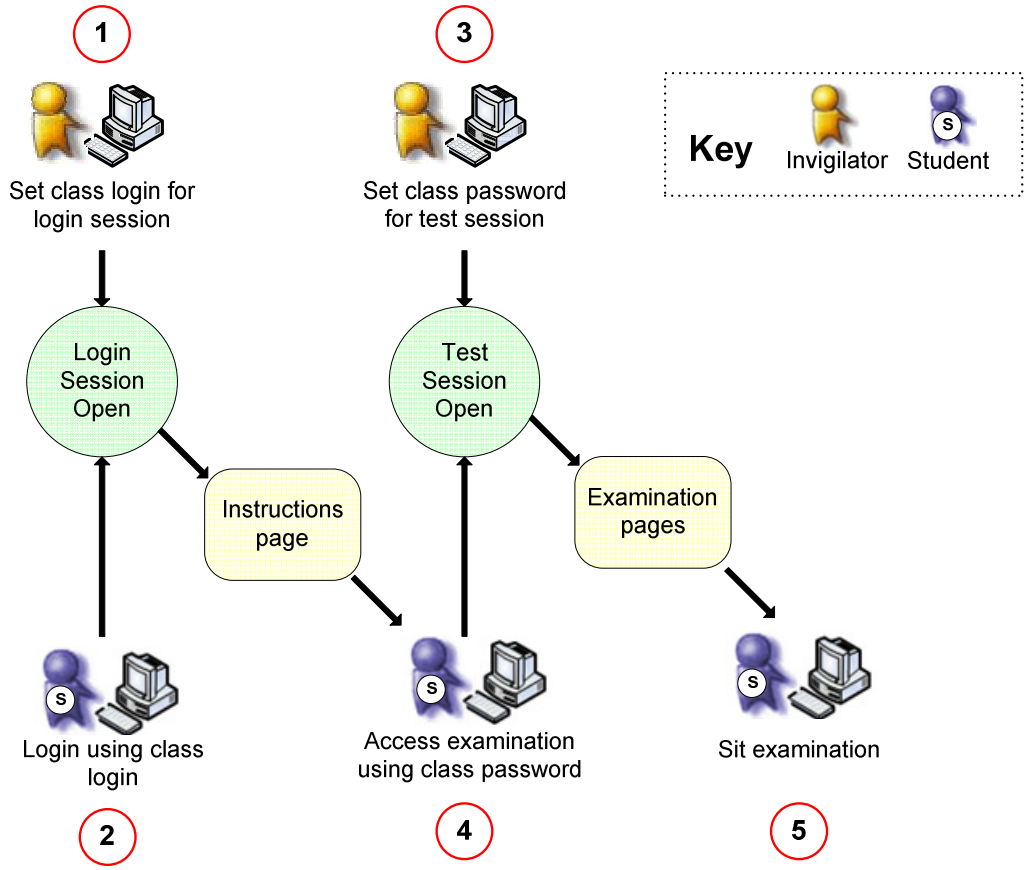

Figure 2: ExamOnline's staged login process puts invigilators in control

There are three important points to note:

- There is no notion of candidate registration in the system – that is, there is no need to create a list of participants who are expected to take the examination. Rather, the system simply creates a unique test session for each student who logs in to take the test. As with a normal examination, verification of student identity (e.g., by means of a matriculation card) is the duty of the invigilator;
- Accordingly, the system uses a confirmatory login process, where students are asked to re-enter key information (e.g., their matriculation number) to ensure valid input;
- Students leaving the examination room and subsequently trying to re-login to the test will not be able to access their test – a second level administration password is required for re-logins.

The screenshot in Figure 3 shows the invigilator's view of an open test session. The screen displays the login details that the candidates need to access the examination and enables the invigilator to change the duration of the session, if required.

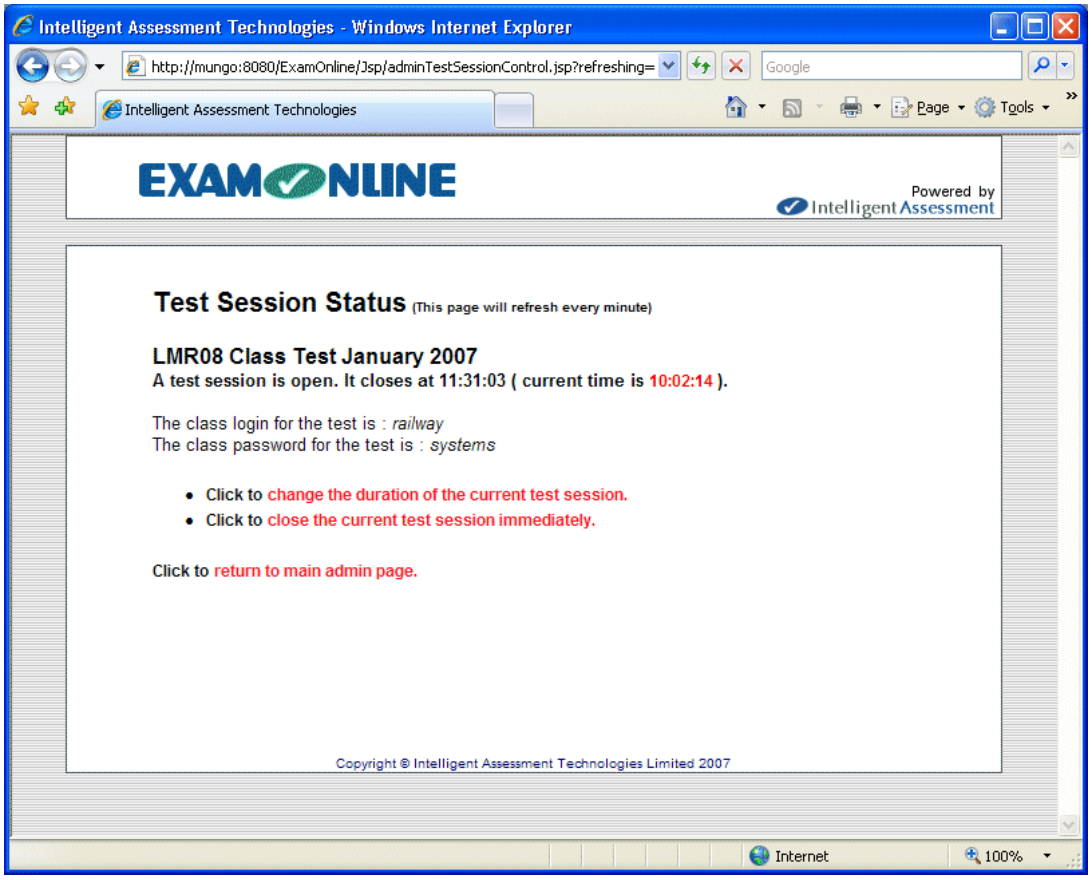

Figure 3: Invigilator's view of an open test session

The Student View

The main examination screen for the candidates is the examination document previously authored by an administrator. Students answer each question by clicking on a link next to the respective question text (see Figure 1). This then provides an answer session for the question chosen

For the individual answer session, the candidates are presented with a screen providing a simple and familiar word processor interface, supporting:

- Composing text;
- Copy/cut-and-paste;
- Font styles;
- Bulleting;
- Numbering;
- Text alignment.

A substantial amount of 'white space' is provided for the candidate's use, encouraging not only a discursive style of writing but also allowing the student to present his or her views appropriately. The screenshot shown in Figure 4

illustrates some of the basic formatting that can be used by students to structure their answers.

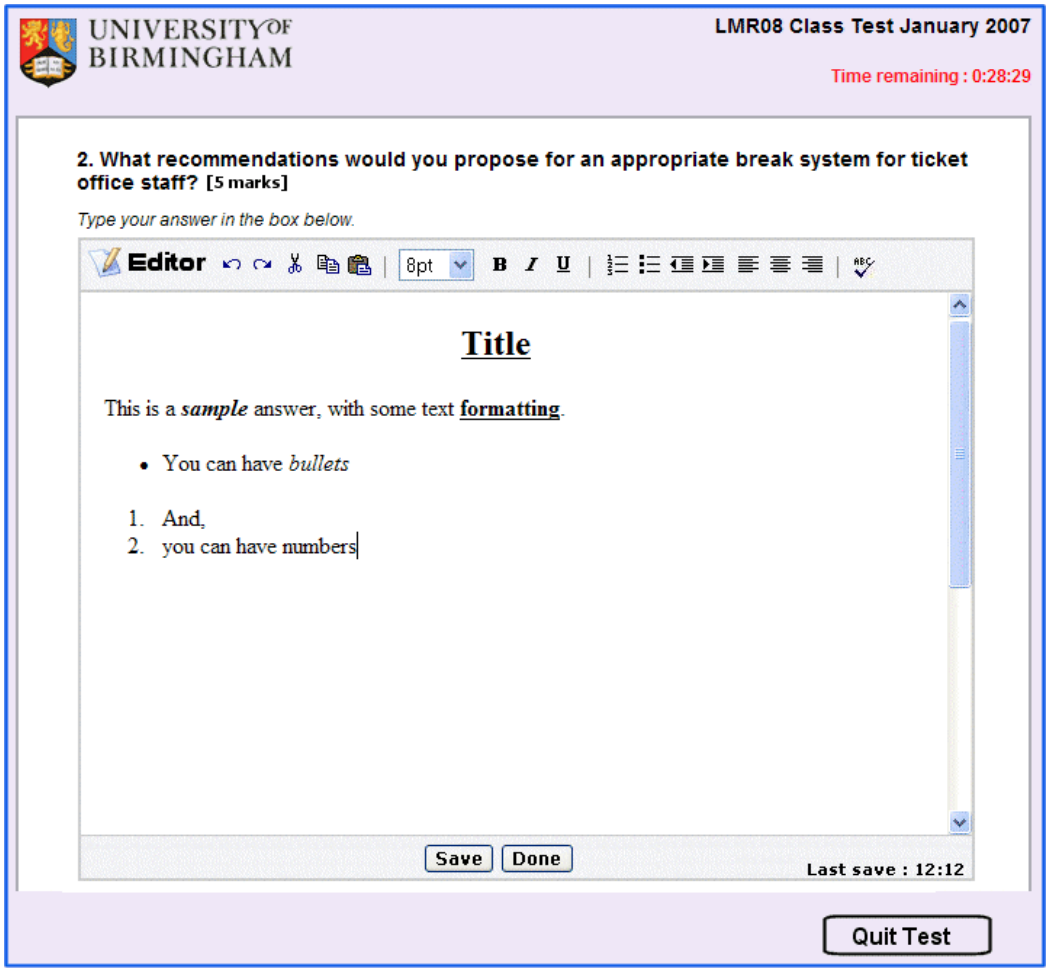

Figure 4: Students use a secure web-based word processor interface to answer each extended answer or essay question

The ExamOnline system is designed to go beyond the capabilities of standard Computer Assisted Assessment (CAA) systems in supporting essay and extended answer questions. The key features thus include:

- Copy/cut-and-paste, and simple formatting;
- Provision of an integrated spell checker (available at the administrator's discretion);
- An "autosave" functionality, taking a back up of student responses every 10 seconds or so.

In addition, the interface has been designed to use asynchronous communication with the server. Thus it can cope with network and/or server outages, re-synchronising as and when the network comes back on-line.

On-Screen Marking of Examinations

The designers of ExamOnline had in mind some key objectives when designing the marking interface:

- Make on-screen marking as simple and efficient as possible;
- Support existing marking practices (i.e., multiple markers);
- Support blind marking.

When markers log into ExamOnline, they are presented with a list of questions / papers to be marked. Clicking on a question brings them to the main marking interface that is shown in Figure 5.

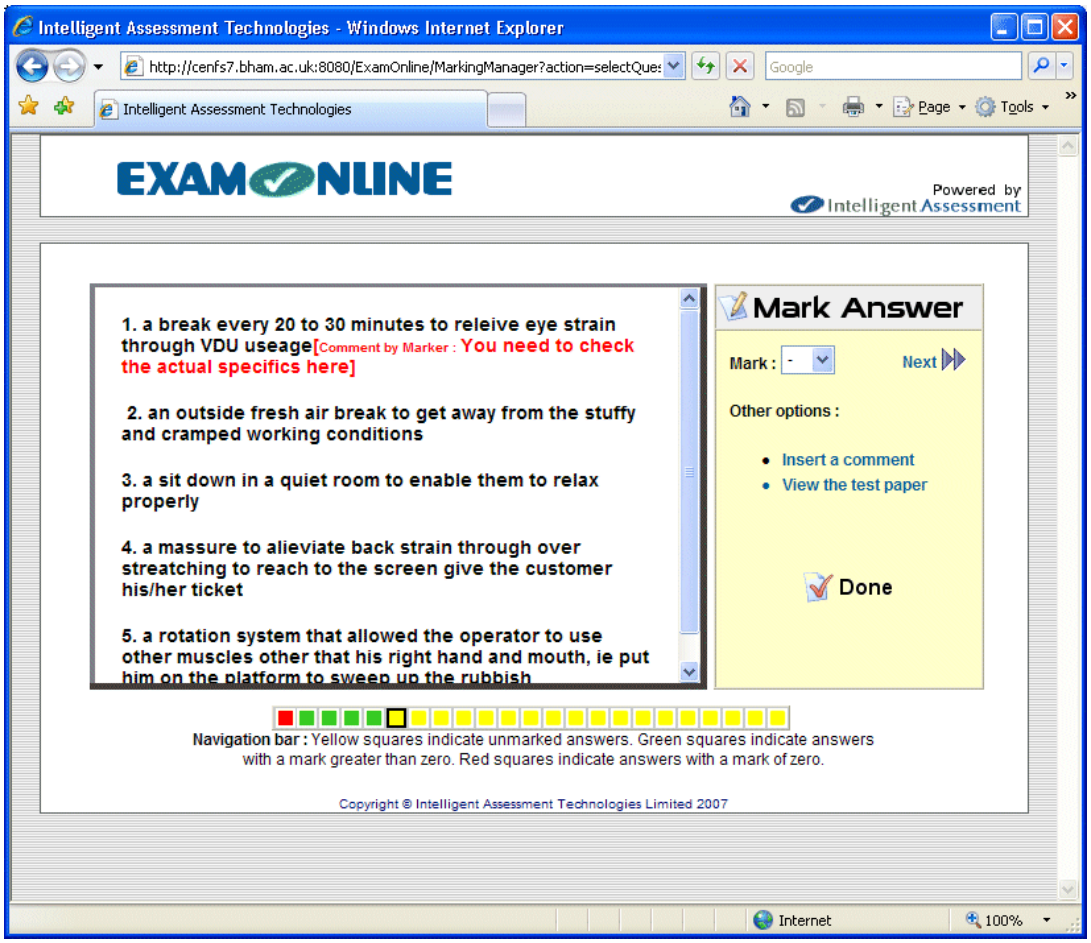

Figure 5: The markers' interface supports rapid blind marking, and also allows for the insertion of comments / feedback into student responses

The interface has been designed to enable marking with the minimum number of mouse movements and/or keyboard input. For short or extended response questions, using the keyboard provides extremely efficient processing of responses, with no mouse usage required at all. We estimate that marking is between two and three times quicker than would be the case for manual marking of scripts and, of course, here we are supporting blind marking.

In addition, the marking interface provides the ability to insert comments against each answer in the event that formative feedback to students is required, whether or not the output is also used in a summative manner. Such comments are shown as annotations (in red) against the student's response, as illustrated in Figure 5.

Security

ExamOnline delivers examinations via a web browser. Accordingly, it is necessary to secure the browser so as to prevent student access to the internet, the local file system, email, etc. To ensure this level of security, students entering the ExamOnline system must first download and run a small Windows executable (itself delivered via the browser from the ExamOnline system). This executable:

- disables system keys (e.g., ctrl-alt-del, alt-tab, etc.);
- installs a 'keyboard hook' to trap browser 'hot-keys' which could otherwise be used to open new browser windows etc.;
- launches Internet Explorer in kiosk mode (that is, with no address bar, toolbars, or buttons visible or available) at the ExamOnline login page.

Once these actions have been carried out, candidates can only navigate and indeed exit the browser by using the interface provided by ExamOnline. Similar functionality is also available using commercially available secure browsers, such as Respondus LockDown Browser (Respondus, 2007).

Note also that, once logged in, students are unable to re-login without being provided with an additional invigilator password. Therefore, they cannot leave the invigilated environment and re-access the examination.

Robustness

The student interface has been carefully designed to make the examination process as robust as possible. Specifically:

- After login, the entire test is downloaded to the student computer. No further communication with the server is required except to save student responses (and for spell checking, if enabled);
- There is an automatic 'autosave' functionality built in, which saves student responses to the server every 10 seconds or so;
- Student responses are saved to the server asynchronously. If the network / server is temporarily unavailable, a local copy of the responses is kept and synchronisation is re-established with the server when the network / server becomes available again.

These and other features are implemented using an Ajax (Garret, 2005) client and a J2EE Java platform on the server, as shown in Figure 6.

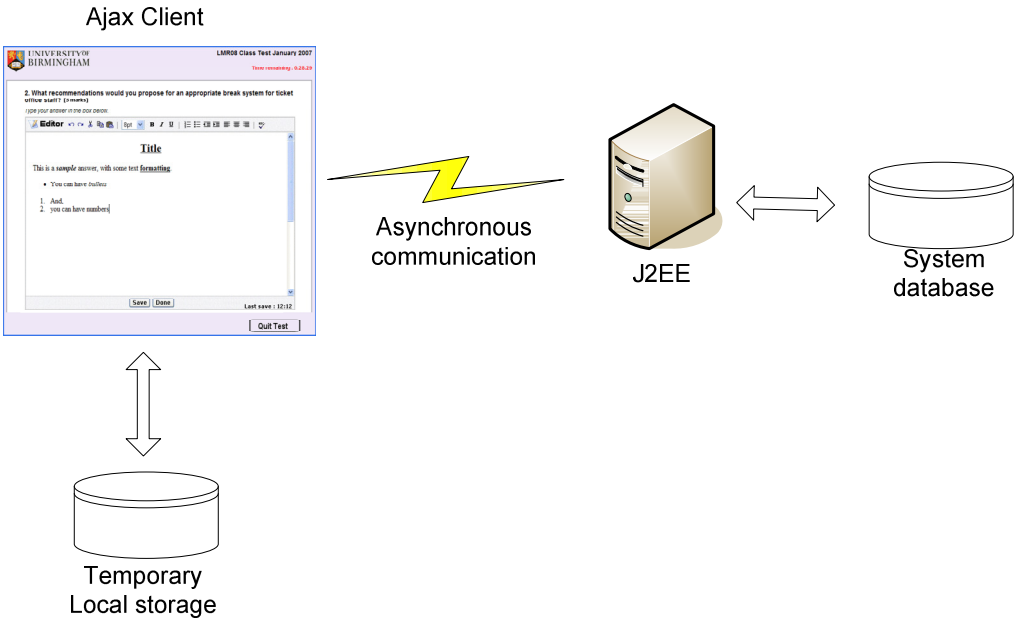

Figure 6: An Ajax client delivers the test to the student. This supports asynchronous communication with a J2EE server, providing robustness when network and / or server become temporarily unavailable

Results of Live Pilots

At the time of writing, ExamOnline has been used to deliver two live class tests with a largely identical student cohort. The system was modified and developed between the two tests, based on student and examiner feedback. Two academics were involved in setting the respective exam papers and in assessing the answers on-line.

Issues Relating to the Student Experience

From observation of the examination sessions delivered to date on ExamOnline, the following points can be made :

- Students were initially cautious of taking summative examinations on-screen rather than on-paper. However, this effect was largely confined to their first encounter with the system. In a subsequent session, they 'just got on with it';
- The less computer literate students commonly expressed a desire to have a longer time period within which to compete the on-screen examination, compared to the paper version;
- It was noticeable that students readily took to re-visiting and re-editing responses to questions – much simpler and more effective in an electronic system than when using a paper-based system;

- A number of refinements to the interface were requested by the students after the first trial, and subsequently implemented. Further refinements are still outstanding (see further work);
- Accessibility was a problem for a student with very poor eye sight, who felt better able to view and answer questions on paper than on-screen. Some work on resolving this issue is planned for a later trial.

Students views were collected formally as part of a short survey conducted during the year-end examinations (see next section) and a selection of comments were received, as follows:

- I found the computer based test OK no problems.
- Ability to cut and paste similar text [useful].
- Adequate time should be given for those with limited typing skills and accuracy.
- I think the time and number of questions needs to be carefully considered.

Overall, the response from students has been favourable, noticeably more so after the second trial than after the first. This supports our view that, as these kinds of systems become more widespread and familiar, it is likely to be the paper-based examination process which will increasingly draw criticism from students.

Statistical Survey of Students' Views

The course team conducted a brief survey of the students' experience of all their examinations in the academic years 2005/06 and 2006/07. This included paper based year end exams (lasting 2.25 hours) and the class tests (lasting 1.25 hours), two of which had been used for this trial. Three of the questions are relevant to the present paper:

1. Indicate the difficulty of each class test already completed (high, medium, low, do not know);
2. Indicate the suitability of the class test format in each case (high, medium, low, do not know);
3. How do you rate your computer skills? (high, medium, low, no answer)

The survey questions purposely covered both paper based and computer administered examinations to ensure that the team would be able to draw fair and comparative lessons. The responses from the 30 participants in the survey were translated into numerical values (high = 3 and low = 1) and averaged, with the following results:

- Level of difficulty: The average for the two paper-based tests was 2.19 and that for the two computer-based ones was 2.22, both out of 3;
- Suitability of format: The average for the two paper-based tests was 2.17 and that for the two computer-based ones was 2.32, both out of 3.

The difficulty of both types of test was thus viewed as about right although the computer based format appeared to be slightly preferred over the paper-based one. The responses were then correlated with the students' own assessment of their level of computer literacy. For the first pilot, this indicated that students with a high level of computer literacy found the test more difficult than those stating a lower level of expertise, possibly indicating dissatisfaction with the MK1 user interface. The result for the second pilot, with a much improved interface, aligned expert users with a perception of lower difficulty.

Students were asked three further questions, but their answers were only analysed if they had taken part in one of the computer based tests:

A. Would you be happy to be assessed in a class test in this way again?

B. Would you be happy for all class tests to be run in this way?

C. Would you be happy to sit a year-end exam in this way?

19 out of 23 respondents answered 'yes' to question (A), with 3 abstentions; 13 replied 'yes' and 7 'no' to question (B), also with 3 abstentions, while only 5 people would be happy to use the computer-based approach for an end-of-year exam (C), with 15 answering 'no' and 3 abstaining. Overall, the team feels that this outcome represents a positive result for the pilots.

It is worth noting again here that the MSc students who participated in these tests are all mature students, and few of them are what has been termed 'digital natives' (Prensky, 2001). We might reasonably expect therefore that the attitude of undergraduate students towards on-screen testing will be yet more positive (as has been found in other studies with younger participants (Sim, Horton, 2005)), and we hope to investigate this shortly.

Issues Relating to the Examiners' Experience

The two examiners involved in the trials had 12 and 8 years of experience respectively with assessing paper based class tests on this course. They both had concerns, initially, about the students' ability to cope with typing answers on-line. However, they had also seen a decline in students' ability to hand-write at the speed necessary to succeed. Their observations were as follows:

- The marking interface is user-friendly and requires only a minimal amount of training;
- Reading the answers is much easier than when having to decipher poor handwriting. Much ambivalence and subjective interpretation is removed from the assessment;
- Marking is fairer since the system allows marking question by question thus eliminating both positive and negative influences from poorly / excellently answered questions before and after. Both markers chose not to use the paper by paper assessment option;
- The progress bar gives a very positive indication to the marker as to how much has been achieved and how much is still to do…

Feedback to the designers of ExamOnline resulted in a number of modifications to the interfaces between the first and second live trial and also in many of the suggestions for further development, discussed later on in this

paper. Overall, they declared themselves very satisfied with their own experience of using the system.

Future Work Planned

There are a number of areas where ExamOnline is currently being improved on the basis of the two live pilots, and in preparation for further roll-out :

- Inclusion of differentiated mark schemes for individual questions, which will be integrated into the marking interface;
- "Offline marking", to support "as and when" marking on personal computers and laptops, with later synchronisation with the main system;
- Integration with back end systems for outputting results;
- Integration with a free-text computerised marking system to provide automatic marking of short answer questions (Intelligent Assessment Technologies, 2007);
- Support for drawing diagrams when answering questions, potentially on-screen (Thomas, 2004), but with an option for hand-drawing and paper based submission of calculation-steps;
- Enhanced accessibility for sight impaired students;
- The ability to build up (and insert from) a list of standard comments as marking of a question progresses;
- Addition of simple QA measures into the marking process (e.g., item statistics);
- Support for double marking of responses.

Conclusions

A new e-assessment system, ExamOnline, has been specifically developed to deliver summative, essay style examinations in an HE/FE setting. The system has been designed to support existing examination processes, to provide a better and more relevant examination experience for an increasingly digital cohort, and to support an efficient blind marking process. Initial pilots have confirmed that the system provides an effective and efficient means of deploying traditional essay style examinations on-screen and that it improves in many ways upon the existing paper-based process. The system will undergo further development and roll-out in the coming months, based on the feedback received during continuing live pilots with students on a Masters programme. Further pilots with undergraduate students are planned for the coming months.

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