Getting started with e-assessment

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Information Sheet

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1. Introduction

1.1 Aims

This report is intended to provide a good grounding for those new to the topic as well as an excellent refresher for those who have been using objective testing for a while. The purpose of this document is to introduce you to the field of e-assessment. After reading it you should:

- have a clear idea of what e-assessment can and cannot do, its advantages and limitations
- be aware of different approaches to e-assessment and their implications
- have a clear idea of what e-assessment might offer your own teaching and assessment practice
- have some idea of what's involved in setting up e-assessment, how to get started and where to get further information

1.2 Background

In a 2004 speech, Ken Boston, Chief executive of the Qualification and Curriculum Authority (QCA), declared that: "On-screen assessment will shortly touch the life of every learner in this country. Advances in technology have given us … a massive potential to increase participation, learning and performance" (Boston 2004). Furthermore in their Blueprint for delivering e-assessment the QCA proposes that by 2009 e-assessment will become "increasingly routine" (Qualifications and Curriculum Authority 2004)

More recently Crisp (2007) found that "Surveys conducted in the UK have shown a significant number of higher education institutions using computers for assessment".

This report presents some of the practical implications of this trend by focussing on the aspect of computer based assessment known as e-assessment, and considering what it has to offer.

1.3 What is e-Assessment? Definition and exclusions

The focus of this report is objective e-assessment. Here the term e-assessment is used to refer to forms of assessment that are stored, delivered, answered and mostly or completely marked automatically using Information and Communications Technology (ICT), such as Moodle. This definition is in line with the JISC whose own definition of e-assessment is: "The end-to-end electronic assessment processes where ICT is used for the presentation of assessment and the recording of responses." (JISC 2009 - http://www.jisc.ac.uk/assessment.html, accessed: December 2009)

E-Assessment is distinct from other forms of computer assisted assessment where for example scripts are submitted via ICT but marked by people. The corollary to this is that by necessity, the questions in e-assessments are almost exclusively objective, that is they have a single or very clearly defined set of correct answer(s). Other ways of using computers to support assessment activities such as online assignment submission, assessment of blogs, wikis etc, online self and peer-assessment and e-portfolios are beyond the scope of this report and will be covered elsewhere.

2. What are the benefits for Learning and Teaching?

2.1 Benefits

Marking questions automatically by computer rather than by hand offers potentially large savings in marking time, a benefit even more significant with increasing student numbers. Note, in principle automatic marking ought to save large amounts of academics' time and therefore result in cost savings. However there is so far very little evidence available of the impact on costs.

1. Where appropriate to the aims of the assessment, students can be provided with **instant feedback** on their responses. This may help to address the shortcomings in feedback to students identified in the National Student Survey (Williams and Kane 2008). Large scale evidence collected at the University of Bristol indicates that this is the aspect of e-assessment that students most value.
2. Marking by computer is truly **objective**; computers do not get tired or make errors.
3. Marking is **instant**; student marks are available and can be acted as soon as the assessment has ended. This enables: teaching to adapt to assessment results; immediate streaming of students and streamlined examination procedures and timetabling.
4. **Scaleability**; in principle the same effort is involved in delivering e-assessment to 200 students as it is to 20. However this is less so with simultaneous, invigilated and credit-bearing tests.
5. **Any time any place**; e-assessments can be taken on any networked computer, and even on mobile devices in many cases. This allows assessments to be taken in the students' own time as preparation for teaching sessions, and supports distance learning where assessments can be delivered to remote centres.
6. It is very **easy to store, edit, reproduce, recombine and reuse** assessment questions held in an electronic database. Assessment items can be analysed for example for difficulty and average time taken, and accurate data can be produced on the validity and reliability of questions and tests.
7. Compared to traditional essay-based examinations containing questions on a small section of the curriculum, the use of banks of objective questions allows much **wider coverage of content in questioning**.
8. Students like being able to **revisit questions** and change their answers as much as they like before submitting without fear of spoiling the paper (as can happen with Optical Mark Reader sheets for example).
9. Compared to taking a test on paper, e-assessment allows a **wider range of tasks and activities**, including drag and drop exercises, the use of high quality colour images, three-dimensional visualisations, simulations and many others.

2.2 Limitations/Drawbacks

1. **Only allows objective questions**, which greatly limits the scope for assessing discursive or open-ended topics. Hence e-assessment is much more widely used in science, maths and language oriented disciplines rather than for example the arts and social sciences. Questions have to be designed very carefully to eliminate any ambiguity or lack of clarity.

2. Although it is possible to create an enormous range of question styles given appropriate software and the requisite programming skill, most off-the-shelf e-assessment systems only offer a **limited range of interaction** types. Many activity types which can easily be incorporated into pen and paper exercises, such as drawing and graph plotting, are not available with standard e-assessment systems.
3. Most question styles used with e-assessment require students to recognise the correct answers from a list of options, rather than to produce the answer unprompted from their own memory.
4. Associated with this is the belief that objective testing does not allow for assessment of more sophisticated reasoning or in-depth understanding. However it is argued that with careful design and use of certain question styles (such as case analysis, data analysis and assertion:reason questions) it is possible to create objective questions that test higher levels of knowledge.
5. In addition to its inherent limitations, e-assessment is also **resource-intensive** in several ways
6. e-Assessment is very **time-intensive** to set up initially, mainly in the time to create a well-written bank of questions.
7. An **additional cost** is involved in setting up the software and inputting the questions, assembling them into a test and making sure everything works.
8. Synchronous assessments, particularly when credit-bearing, require a great deal of **careful organisation**, a large amount of computer infrastructure, development of specific procedures, and the involvement and frequently training of additional administrative, e-learning and technical support staff.

2.3 Do students like e-Assessment?

Research comparing student performance on paper-based versus computer-delivered tests has been not yet been completely conclusive. While for example Ricketts & Wilks (2002) and Lee & Weerakoon (2001) report that students did worse in computer based tests, a large study of 8th grade maths students in the US found no significant differences except that computer delivery favoured the students most familiar with computers (NCES 2005). By contrast Lee and Weerakoon (2001) found no correlation between results and student computer skill, or with computer anxiety.

Ricketts & Wilks (2002) and O'Hare (2001) found that students are accepting of online assessment, while work at the University of Bristol (Cook 2008) found that although acceptance in principle may be high and some of its features may be very popular, particularly instant feedback, in practice it is less accepted for credit-bearing assessments and anxiety around technical failure is very high.

3. What does e-assessment look like?

Here we present examples of the most common e-assessment questions styles, although there are many possible variations of these basic styles. For more examples and more about the merits of the different question types, see the University of Bristol's interactive guide to writing objective assessment questions for online delivery: http://esu.bris.ac.uk/esu/e-assessment/writing_e-assessments/index.htm

3.1 Multiple Choice

This is the simplest and most common type of interaction in e-assessment. Possible variations include extended MCQs which present a long list of options, and hot spot choice questions where the students selects the correct area on an image. Although MCQs are commonly seen as suitable for testing only simple facts, used creatively they can be used to present a diverse range of far more probing questions, including questions with images, data analysis questions, and Assertion: Reason questions (Williams 2006).

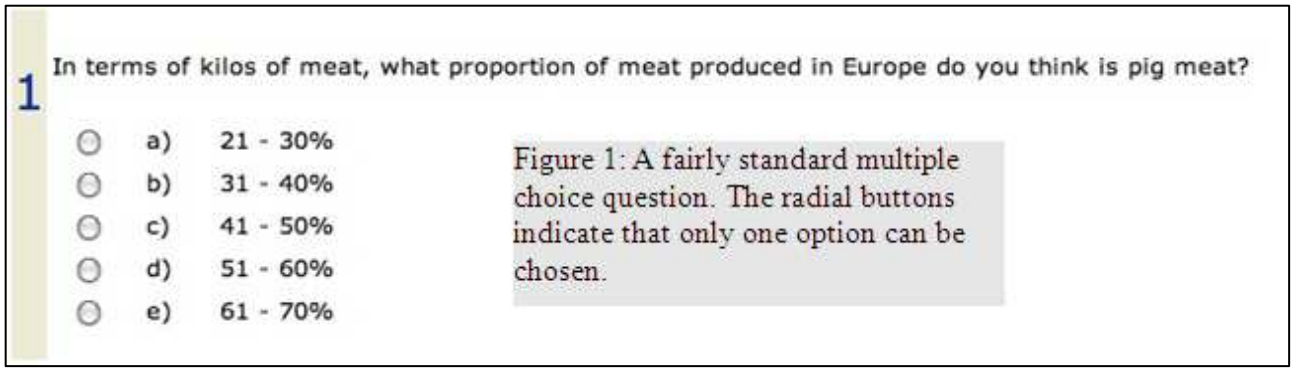

Figure 1: A fairly standard multiple choice question. The radial buttons indicate that only one option can be chosen.

3.2 Multiple Answer

Multiple answer questions (MAQs) are also popular and very versatile. Variations include extended MAQs, and True/False/Don't know questions. One of the challenges they present to authors is how to design a valid scoring system.

Figure 2: A multiple answer question. The check boxes indicate that more than one answer can be chosen.

3.3 Matching

Matching questions come in many forms and have many purposes. They can be very powerful as data analysis questions, but also can be used for ordering exercises, labelling activities and many others. Matching exercises can also be presented in drag and drop format (see the example below).

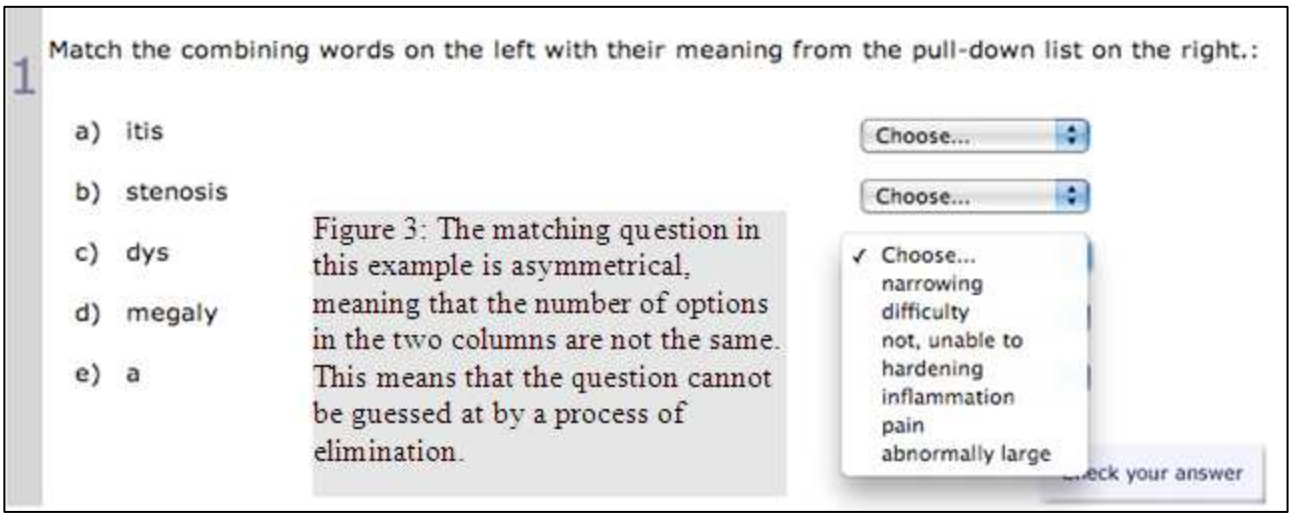

Figure 3: The matching question in this example is asymmetrical, meaning that the number of options in the two columns are not the same. This means that the question cannot be guessed at by a process of elimination.

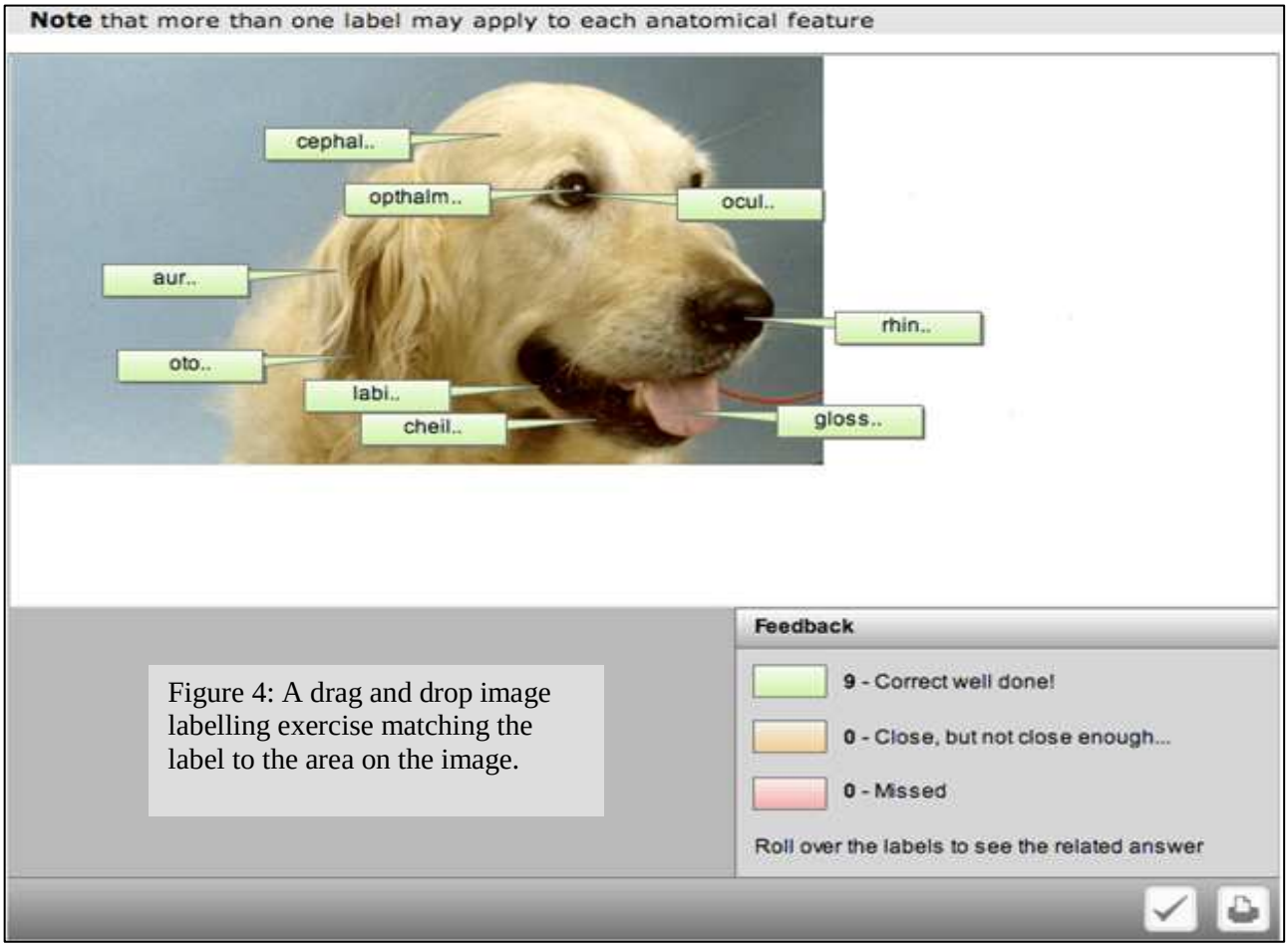

Figure 4: A drag and drop image labelling exercise matching the label to the area on the image.

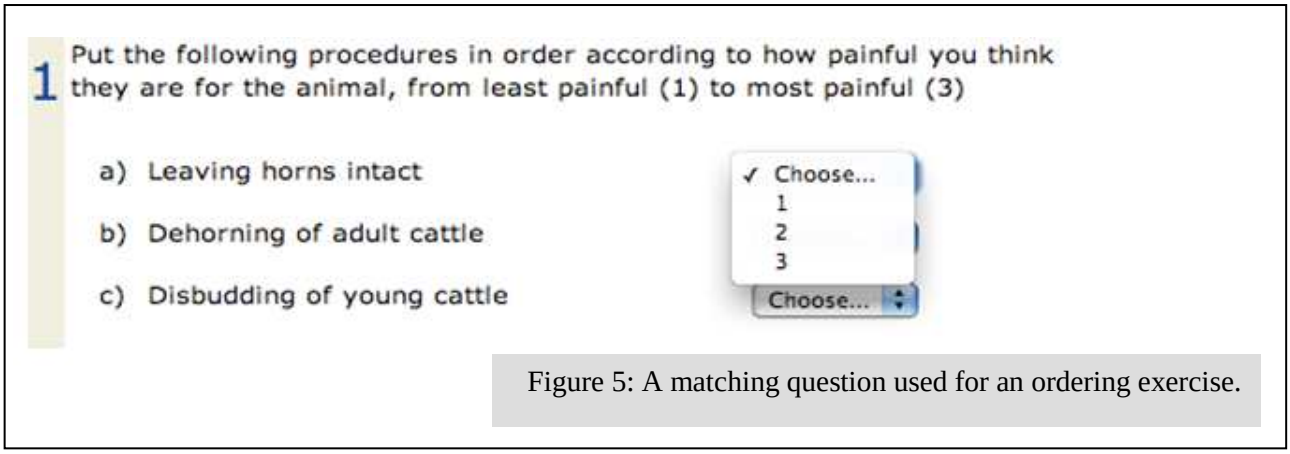

Figure 5: A matching question used for an ordering exercise.

3.4 Gap fill question

Gap fill questions allow short piece of text to be presented with missing words that the student must fill in. The missing words can either be presented as blanks, as a pull down menu or as words in a word bank from which the student must select. These questions are most powerful when a separate set of options is presented for each missing word (as in the example below).

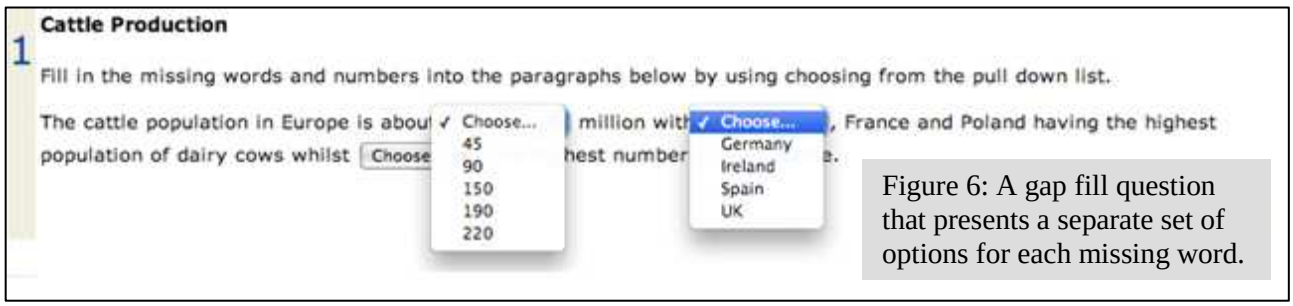

Figure 6: A gap fill question that presents a separate set of options for each missing word.

3.5 Text or Number entry questions

The advantage of this style of question is that it can test true recall rather than just recognition from a set of options. The drawback is that the computer can only allocate full marks for answers that have been anticipated by the authors (including variations in spelling). This means that these questions can only be used where the range of possible answers is very limited (e.g. a unique name or a number).

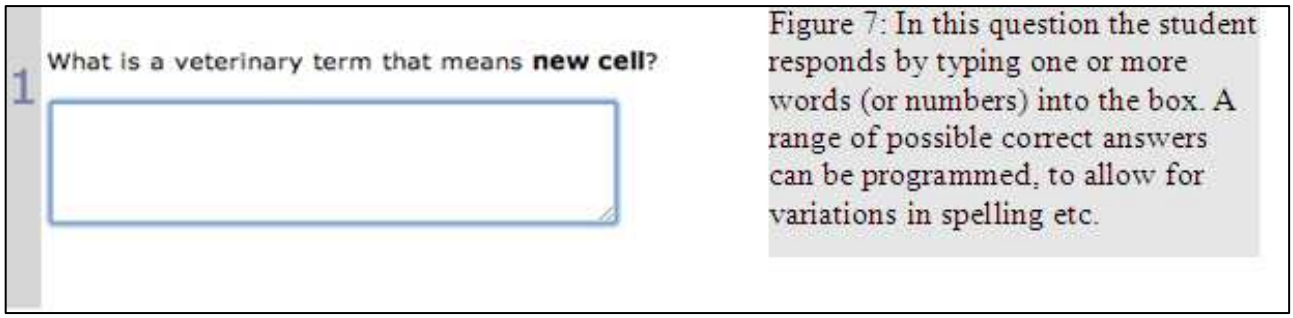

Figure 7: In this question the student responds by typing one or more words (or numbers) into the box. A range of possible correct answers can be programmed, to allow for variations in spelling etc.

4. Different types of e-Assessment

E-Assessment can be divided into different types according the main purpose of the assessment (though these types also apply to conventional assessments):

- **Diagnostic assessment** – normally at (or even before) the beginning of the teaching programme, for placement or streaming purposes, or to identify necessary remedial work. e-Assessment's instant marking can be of great benefit here.
- **Formative assessment** – allows students and their teachers to gauge how much has been learned, identify areas where further work is necessary and help students to reinforce their learning. e-Assessment allows students to receive feedback while they are still focussed on the subject.
- **Summative assessment** – has as its aim the measurement of student learning, usually at the end of a programme of study. Success is normally the prerequisite for award of grades, degrees or progression to further study. Feedback, other than a mark or grade, is not normally provided.

It is also necessary to distinguish between **low stakes**, **medium stakes** and **high stakes** assessments because, for example a mainly formative assessment may have a small number of marks associated with it in order to ensure students do the test (a medium stakes formative test). Alternatively, an online test may be summative in purpose but only represent a small proportion of the overall assessment and so have minimal impact on the student's final grade (low stakes summative).

A further important distinction is between **synchronous** (done by all the students at the same time) or **asynchronous** (can be done at any time within a specified period) assessments. Related to this is whether the test is invigilated (normally implying that all students are gathered in one or more PC Labs), or un-invigilated (where for example the student takes the test at home).

It is important to be clear about these distinctions especially when planning the resources required for e-assessments. For example synchronous assessments are generally much more resource-intensive, but even more so when they are for a high stakes examination where it is absolutely vital that everything runs smoothly.

4.1 Approaches to scoring and designing e-assessment

There are a number of other approaches to assessment which are enabled or at least made easier by e-assessment, including:

Negative marking and MUGs score – negative marking is believed to discourage students from guessing answers particularly to multiple answer questions. Internal negative marking means that wrong choices result in loss of marks given for correct responses within the same question, but the lowest mark for the question is 0. Cumulative negative marking means that a negative mark for one question will be deducted from marks awarded for other questions.

A useful basis for designing negative marking schemes is the Mean Uneducated Guess (MUG) score for the question – meaning the mark you would get if you answered the question randomly, which should result in a score of 0 (McCabe and Barrett 2003).

Whichever scheme is used, it is essential that students understand how it works and have opportunities for practice before they face it in any credit-bearing tests.

Confidence weighting – (or certainty based assessment). The student is asked not only to answer a question but also to indicate how confident they are in their answer. The mark is based on a combination of these two factors, as shown in Table 1 below.

	High	Medium	Low
Correct	3	2	1
Incorrect	-6	-2	0

Table 1: Scoring matrix most commonly used in certainty based assessment.

Proponents of this approach claim that it discourages students from blind guessing, and fosters reflectiveness and self-awareness in students (Gardner-Medwin and Curtin 2007, Nicol 2006). Experience suggests that as long as students understand the marking system and have opportunity to practice, they accept and even value this approach.

Adaptive testing – the test that the student receives is automatically adapted by the system according to their performance on earlier sections of the assessment. For example, a low score on the early sections of a test will result in easier questions being presented in subsequent sections (or vice versa), or a low score on a particular topic will result in additional questions being presented to provide further practice with that topic.

Use of questions in online learning material - objective computer-delivered questions similar to those described earlier are also used extensively in online interactive learning material, often in a pre- or post-test, but also frequently as part of the body of the material. Their purpose is to make the material more engaging and promote active, constructivist learning. However it is important to be aware that questions used in this way are intended to present material and not to test, so that the answer must be deducible from some combination of:

1. previous learning
2. information previously presented in the tutorial
3. inferences from material presented within the question

Also questions for this purpose do not have to be designed so rigourously to prevent inductive guessing.

5. Some case studies of use

The following case studies illustrate a range of ways in which effective use has been made of e-assessment.

1st and 2nd year Physiology: Using pre-practical quizzes to improve student engagement in practical laboratory work.

In years 1 and 2 of the University of Bristol Physiology course around 50% of contact time is lab related, resulting in 38% of the mark for Year 1 and 20% for Year 2. However, it was found that students prepare poorly for Yr 1 laboratory work and that Yr 2 Students had poor laboratory skills. The project aimed to address this through the introduction of compulsory online pre-practical quizzes.

Initial drafting of questions, discussion and revision was done on paper and once finalised entered into the online system where questions were trialled, checked for bugs and feedback was developed. A sub-group of the Department Teaching Committee was set up to oversee the process.

Beginning in academic year 2007-2008 each of the 180 1st year physiology students were given a mandatory pre-practical test to be taken at any time during the 7 days prior to each of the 11 lab sessions. Multiple attempts were allowed and no negative marking was used. Explicit feedback was provided for wrong answers. Failure to achieve the 40% pass mark meant the student would not pass the Unit.

The main cost was in staff time, estimated at 255 hours in total, mainly in writing and setting up the quizzes, reviewing questions, agreeing policy, and setting up a system for results analysis. Most of this will not be incurred in future years.

Student evaluation was very positive and acknowledged that the tests had forced them to prepare more effectively, but also that they had helped their learning. Immediate feedback on questions was much appreciated. Only 2 of 180 students failed to achieve the pass mark.

In 2008-2009 the approach was rolled out for students on other programmes who share the same practicals (Medicine, Dentistry, Veterinary Science). There are also moves into other related subjects (e.g. Pharmacology).1

Use of e-Assessment for end of unit examinations in 3rd year Clinical Medicine at the University of Bristol.

Increased student numbers, coupled with reductions in academic staff mean that manual marking of end of unit examinations is no longer viable. There was also a requirement to obtain results within days of the examination. The aim was therefore to replace the previous manually marked MCQ examination with a version delivered and marked by computer.

The academic lead for each of two subjects in the exam (pathology and anaesthesia) took responsibility for writing questions for their own section. These were entered into the system by one of the academics, but then checked and tested by e-learning support staff.

Some time prior to the exam a formative test was held under conditions equivalent to the exam, including examples of all the questions styles used in the actual exam. This formative test provided immediate detailed feedback and explanations, which was highly valued by the students.

For the exam itself the 135 students were divided into 2 sittings. The 2nd group were coralled in a quarantine area until the 1st sitting had left the building. Two adjacent computer laboratories were used with a total capacity of around 100 PCs. PCs were configured to prevent students from looking at any other window during the exam or accidentally closing the exam, and central monitoring software was used to observe student PC activity. Two additional e-assessment invigilators were present to advise and trouble-shoot any problems.

Load on the system was managed by staggering the start and by dividing the exam into two separately-timed 1 hour papers. The automatic timer ensured that all students had equal time, while students with dyslexia were set to automatically receive 25% extra time.

In general the process ran very smoothly except on one occasion where a system problem delayed the start of the exam by 15 minutes. Results were collated and made available on the day following the examination, rather than the 2 weeks it had previously taken with the Optical Mark Reader (OMR).

Some students disliked reading long questions on-screen so in subsequent years questions were also provided in print. Students felt nervous about possible technical problems, but they liked being able to change their answers repeatedly without fear of spoiling their paper (as may happen with an OMR sheet).

Although this initiative was seen as generally successful, it has been decided not to continue in future years. Due to forthcoming curriculum changes there will not be sufficient computer facilities to accommodate the numbers involved. Although it would theoretically be possible to run the exam with multiple sittings, this was seen as too complex logistically and as risking appeal from students who felt disadvantaged by the timing of their exam.

University of Bristol Language Centre – using e-Assessment to help speed up the streaming of students

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At the beginning of each academic year students registering at the Language Centre are given a diagnostic test to place them at the correct level. Traditionally this was marked by hand meaning that students would not normally be placed until week 5. e-Assessment was introduced to speed up this process and save on marking time.

In the first year of the initiative, diagnostic tests were created for French, Spanish and German, all consisting of 50 Multiple Choice questions. Some of these used existing questions imported from other formats, others were written from scratch. These were written and reviewed by the Language Co-ordinator for each language, who either entered them into the software themselves or passed them on for processing by the University e-Assessment support officer.

Students took the test as they arrived at the Language Centre to register during Fresher's week. This was done on a rolling basis in a room with a capacity of 14 computers – if the room was full any new arrivals had to wait until there was a space. This took place over 3 mornings. Full instructions were stuck on to the desk next to the PC, and the PC also showed a Welcome screen with additional instructions. University e-Assessment support staff were on hand to assist where necessary. Students had a 30-minute time limit.

Altogether 256 students took the placement test, and were streamed into the appropriate levels at the end of registration week instead of week '5'. Furthermore tutors did not have to use the first two hours of class in the first week of teaching for diagnostic testing and did not have to mark the paper. Altogether the project saved 9 hours of teaching hours and 10 hours of marking time.

Using online diagnostic and formative self-tests to ensure that University of Bristol 1st year Civil Engineering students have essential mathematics skills.

The trend over the past 20 years is for the 70 or so students arriving for their 1st year in Civil Engineering to have less consistent and generally lower levels of existing mathematics skills. A good level of basic maths as well as more advanced concepts in areas such as mechanics are essential for this subject.

For several years this has been addressed via a mandatory mathematics catch-up course, originally comprising a paper-based pre-course diagnostic test, face to face teaching and a written paper examination. Since manual marking was very time-consuming it was decided to convert existing questions from both diagnostic and summative tests into an e-assessment.

This has worked particularly well for calculated formula questions, as the software can automatically generate multiple questions using the same formula and random values, but less well for questions which require a response in the form of a formula, as these cannot be marked automatically.

The questions are used in 3 ways:

1. The diagnostic paper test has been replaced by self-paced individual formative practice online including explanatory feedback. This, along with some continued face to face tutorials, now constitutes the bulk of the unit activity.
2. After week 7 there is a formal, invigilated summative online test comprising specifically written questions similar to those in the formative tests.
3. The week 7 test is repeated in week 10 for students who do not pass.

Overall the pass rate is very good; very few students have to retake in week 10. The practice tests are well-used, mostly by the keenest, high achieving students and the weakest, anxious students. Individually, students tend to use it either a lot or not at all.

The summative tests generally run smoothly and the quality of the assessment material appears at least adequate. Potential improvements have been identified but it is currently hard to justify prioritising these within existing workloads.

Derby University – Using formative assessments to increase retention rates among 1st year Economics students (from Powell 2009)

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A progressive set of computer-based formative assessment materials with extensive learning materials and feedback was created to support private study. The aim was to improve students' self-regulating learning skills, the lack of which were believed to result in previously high drop-out rates among first year students.

The materials were developed for a module taken by between 250 and 350 students. The material aimed to prepare students with skills (model building, graphical analysis, basic numeracy, and application of a generalised model to a specific context) required to pass the end of module summative assessment (also delivered online). Material was closely linked to the themes covered in face-to-face lectures and tutorials.

Initial content was authored by the module academics in the form of Word documents, with e-learning staff helping to realise this with the e-assessment software.

The materials were mainly interactive activities such as simulations, drag and pull diagrams, recognition exercises, calculation activities, and concept identification activities, leading to staged applied analysis of real world newspaper articles. The aim was to keep the student active and provide continuous feedback whilst building knowledge and skills. Some activities were designed to help students prepare for class activities and discussions, others to prepare for summative assessments and to promote the use of other learning materials such as lecture notes and books.

Students were told to use the materials throughout the module, were regularly reminded about the materials during face-to-face teaching, and were told the outcomes and usage would be monitored. A weekly clinic provided support in the use of the materials.

Overall the project achieved its objectives; the incidence of A and B grades increased and the failure rate decreased. One unpopular aspect was that the material was only available on campus, although students learned to use it opportunistically to fill in gaps in their timetable. There were also some issues with students failing to read online instructions.

6. How do you get started with using e-Assessment?

The process of setting up e-assessment varies quite widely depending on the type, purpose and scale of the assessment. Although mainly developed with credit bearing and synchronous assessments in mind, the e-Assessment life-cycle diagram shown below (created by e-assessment support staff at the University of Bristol) provides an accessible schematic representation of the process of planning and executing e-assessments.

Irrespective of the type of assessment, some of the key questions to consider are:

- What do you want to assess and what is the most appropriate style of question to realise this? Can objective question styles achieve your purpose?
- How many questions do you need to realise your aim?
- Will you build up a bank of questions for re-use and if so over what period?

- What software is available and what are its capabilities and limitations?
- What resources will you need, in terms of staff, software, computer laboratories etc?
- What resources and skills do you have available, where are these located (department, faculty or centrally), and what training will be required?
- What will be the process of composing and reviewing questions be?
- Who will be involved in the project and what will their roles be?
- If doing credit-bearing examinations, what additional procedures will be needed to ensure security etc?
- What support is available centrally and what are the constraints on this? (e.g. is support available out-of-hours?)
- What contingency measures will be needed?

For more detail about planning e-Assessment, the following is recommended: http://esu.bris.ac.uk/esu/e-assessment/planning_online-assessment.pdf (accessed: December 2009))
This document describes the process of planning e-Assessment in detail (but note that it was prepared for the University of Bristol, so some local variations may apply).

Further documentation and guides are available at the University of Bristol's Education Support Unit website at:
http://www.bris.ac.uk/esu/elearning/tools/perception/resources.html (accessed: December 2009))

Members of the University of Bath are recommended to contact the e-learning Team (e-learning@bath.ac.uk) to discuss your needs further.

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