

ONLINE ASSESSMENT AT THE OPEN UNIVERSITY USING OPEN SOURCE SOFTWARE: MOODLE, OPENMARK AND MORE

Philip Butcher

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Philip Butcher
Virtual Learning Environment Programme
The Open University
Walton Hall
Milton Keynes
MK7 6AA
p.g.butcher@open.ac.uk

Abstract

At the CAA conference in 2006 we reported on the Open University's (OU) adoption of Moodle for the core of its Virtual Learning Environment (Sclater et al, 2006). This paper will describe the eAssessment developments undertaken by the OU during the past two years which have already provided new features in Moodle 1.6 - 1.9 and will provide further features in Moodle 2.0. As part of this process the OU has integrated its own OpenMark assessment system (Marshall, 2007) with Moodle and together these systems have now run in excess of 125,000 tests to March 2008. While there is still much to do the OU will be reducing its financial commitment to developing these systems after July 2008 and this is a suitable time to consider the OU's contribution to open source eAssessment systems.

A commitment to open source

Through 2004 and 2005 the Open University considered how best to develop its online presence. It is not the purpose of this paper to record how the decision to follow an open source route was taken but to describe what followed the announcement in October 2005 that the OU was going to develop its future VLE around Moodle. To reinforce its decision, and in recognition that none of the commercial or open source VLEs of that time were considered to be flexible enough to meet our needs, the university was prepared to invest to build some of the required flexibility into Moodle. £5 million was committed to the development programme that started in 2005 and will end in July 2008. This sum was spread across 11 projects, of which eAssessment was one. But the programme was not only about technical development. It had to take out its message to multiple areas of the university and the investment has included many student facing areas, from the electronic library to considerations of the impact on associate lecturing staff (associate lecturers are the OU's face on the ground conducting tutorials,

marking essays, moderating forums and more.). So while £5 million has been committed for development this has had to cover technical, process and people development.

A separate, major review of the impact of technology on the OU's student support model has also been in progress alongside the VLE Programme.

This paper will focus primarily on the technical developments of Moodle itself; developments that built on the efforts of others and are now in place for others to take further.

As well as the general commitment to financing further developments of Moodle the OU made one further important commitment to the Moodle eAssessment module (the Quiz module) when the university agreed to provide the Quiz Maintainer for the global Moodle community. Tim Hunt has filled this role admirably for the past three years, overseeing all Moodle Quiz developments as well as leading the OU's own technical developments of the Quiz. That Tim has been able and willing to combine these two demanding roles has in turn placed the OU in a powerful position to influence developments of the eAssessment module.

The developing strategy

While the university had evaluated both open source and commercial systems before making its choice, those evaluations could not be sufficiently comprehensive to encompass a detailed technical evaluation of the underlying architectures. Consequently the first year of the eAssessment development was spent obtaining a thorough understanding of what we had 'bought into' and considering how we should move forwards.

Prior to the choice of Moodle the OU had used a variety of CAA systems and had a variety of experiences to guide its decision. The original, paper based, but computer marked, system stretched back to the 1970's and had been used for millions of tests. But while it was given an electronic interface in the mid-2000s it was seen to be too restricted in its question types for modern day use over the internet and it was believed that Moodle could provide most of the common question types that course teams required. It was not considered suitable for further development.

Instead more recent developments had been focused on another local system that offered more flexible question types and was designed primarily to suit the needs of distance learners. This product, now called OpenMark, had been in development since 1996 for use off CD-ROM, had gradually spread to internet delivery in the early-2000's and was extended to offer summative assessment in 2002. Throughout this period OpenMark was gathering a growing following with OU course teams and some of the features of OpenMark (Butcher 2006, Ross et al, 2006) which are not provided in standard CAA systems had great appeal to OU course teams who were seeking to use diagnostic and formative assessments with instant feedback to engage students with their studies. By 2004 OpenMark was considered to

have been sufficiently successful that a reimplementaion to use modern internet technologies was started at Easter 2005 and completed in the same month as the announcement that the OU's VLE was to be Moodle based. But by then OpenMark had made its impact as a system that was in concord with the aspirations of several course teams and it was not going to be easily displaced. In fact throughout the two years it took to integrate Moodle with local systems in January 2008, OpenMark has continued to be the main OU system for eAssessment.

And outside of the home-grown systems we had also used a commercial system, QuestionMark Perception, in the OU Business School, again since the early-2000's. But our experiences served to illustrate how different the OU can be from other universities and mismatches in expectation and implementation led to unsatisfactory outcomes. It was decided to convert the applications that we ran under Perception to either Moodle or OpenMark in 2007.

What Moodle brought was the complete integrated environment for handling all aspects of eAssessment from forms for authoring questions through to reports for course teams. While what was in Moodle 1.5 did not meet all our requirements it was clear that the integration offered more scope for further developments than our local disparate systems. It also followed that if Moodle was to be the backbone of the VLE then it should be central to eAssessment too and many of the core Moodle developments that the OU has funded such as enhanced 'Roles and permissions' have been essential to the eAssessment developments.

But while Moodle might provide the overall architecture the available question types in Moodle 1.5 were less than satisfactory for our needs and the contrast with the flexible questions that OpenMark supports were stark. At this point we asked if we could combine the two and thereby capitalise on our investment in OpenMark. We knew that an earlier Moodle had 'talked' to external question engines through RQP (Delius, 2006) and as the RQP author was also the previous Moodle Quiz maintainer when taking over from him we also discussed our ideas for integrating external question engines. This discussion led to the view that while Moodle would form the administrative core and provide easy authoring facilities for a range of straightforward question types we would not expect to develop all flavours of eAssessment for all subjects across the university in Moodle. Instead we would look to interface to external question engines as necessary.

It transpired that RQP had many similarities in design to that which we had developed locally to connect the components of OpenMark where the test navigator requested questions from the OpenMark question engine. But while Moodle had moved on in 2005. RQP had not and at that time had fallen into disrepair and in choosing how to integrate OpenMark question engine into Moodle we chose to develop the OpenMark interface. And to reinforce our approach the same interface, named Opaque (Hunt, 2007), was supplied to Birmingham University in 2007 for their use in integrating the Stack Computer Algebra assessment system (Sangwin, 2006) into Moodle; at the time of

writing we are bringing Stack to the OU. We also connect to Intelligent Assessment Technology's (IAT) free text server (Mitchell, 2003) as a web service.

Given the OU's support for open source, readers will not be surprised to hear that OpenMark and the Opaque interface are now both open source.

The influence of OpenMark on question interactions

OpenMark is an Open University computer-assisted assessment (CAA) system that has its foundations in computer-assisted learning. It had existed in various guises for almost a decade prior to the arrival of Moodle and it had been designed by OU staff for use in the OU's open learning model. It differs from traditional CAA systems in:

- **The emphasis we place on feedback.** All Open University students are distance learners and within the university we emphasise the importance of giving feedback on written assessments. The design of OpenMark assumes that feedback, perhaps at multiple levels, will be included.
- **Allowing multiple attempts.** OpenMark is an interactive system, and consequently we can ask students to act on feedback that we give 'there and then', while the problem is still in their mind. If their first answer is incorrect, they can have an immediate second, or third, attempt.
- **The breadth of interactions supported.** We aim to use the full capabilities of modern multimedia computers to create engaging assessments.
- **We do not hide the computer.** Instead we harness the computing power available to us to enrich the learning process
- **The design for anywhere, anytime use.** OpenMark assessments are designed to enable students to complete them in their own time in a manner that fits with normal life. They can be interrupted at any point and resumed later from the same location or from elsewhere on the internet.

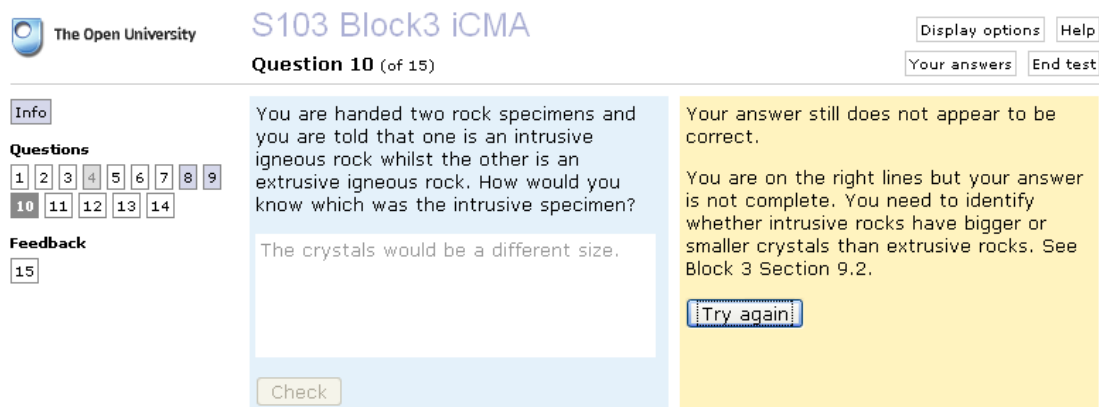


Figure 1: The OpenMark system in 2006 here using Intelligent Assessment Technology's software to perform the response matching

Our experiences in planning, developing, using and evaluating OpenMark (Whitelock, 1998; Jordan et al, 2003) over such a long period provided us with a clear vision of what we might achieve during our stewardship of the Moodle Quiz. In terms of student interactions we wanted Moodle to be more like OpenMark. We asked ourselves how we might achieve this and during 2006 came up with the following underpinning strategies

- re-engineer parts of Moodle to introduce OpenMark-like features
- integrate OpenMark at the test level such that OpenMark reported scores to the Moodle Gradebook (and other systems can do this too)
- integrate OpenMark at the question level such that OpenMark questions could be included in a Moodle Quiz. We also hoped that this latter approach would allow us to tap into other assessment engines such as the Stack computer algebra system and a future QTI engine.

Implementing the strategy

With the decision that Moodle was to be the administrative centre of our eAssessment provision our first task was to ensure that it was robust and reliable and we spent some time cleaning and refactoring swathes of code as we gradually gained confidence in the platform. Between June 2005 and January 2008 Tim Hunt resolved over 1,000 issues in the Moodle bug tracker, this large number reflecting that the Quiz module is a complex piece of software. And in undertaking this work we gained a firmer view of which pieces of the Moodle infrastructure required further work. Several of these reflect the growing maturity and uptake of Moodle as tools which were 'good enough' when Moodle was new needed refactoring as use grew. But it was also the case that Moodle 1.5 (2006) was very much a testing system and not a system geared to helping distance learners learn and OU academics quickly established a long list of features that they would like to see developed to improve the educational experience for our students.

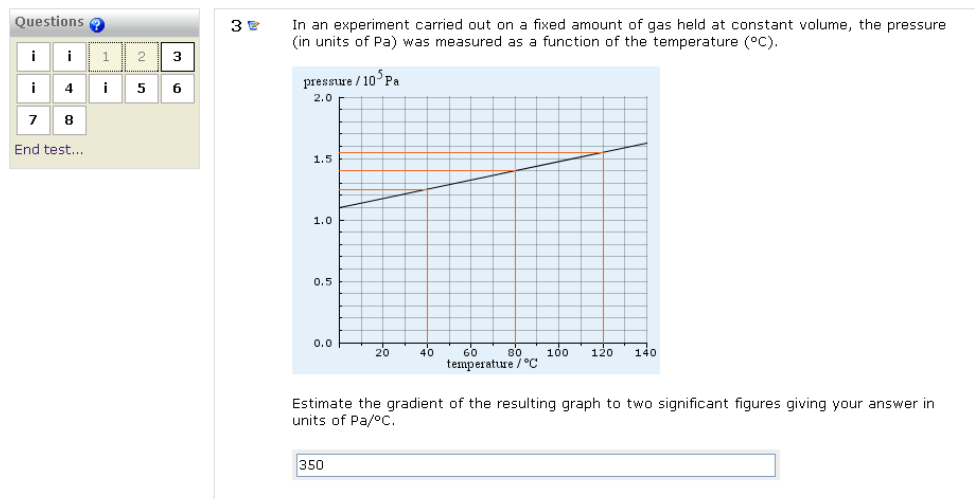
The available resources determined that we could not do everything and throughout the VLE Development Programme we have had to tread a careful path to satisfy the demands of academics who are primarily focused on the student interactions and administrators who wish to be reassured that the supporting infrastructure is in place. As we approach the end of the programme the accepted view is that we have spent far more of our resource on infrastructure developments than we expected to and it is infrastructure developments that dominate the following list.

By December 2006 we had determined to develop further the following Moodle features:

- Authoring forms for questions to enable the provision of feedback and multiple attempts together with updated run-time code to

support the new features (some are in Moodle 1.6 – others will be in Moodle 2.0).

- Authoring forms for a small number of new question types plus associated run-time code.
- Categories for grouping and sharing questions. This work was carried out in Asia but the Quiz Maintainer had a role in its specification (Moodle 1.9).
- Forms in which to build tests and to allow tests to run in one of two modes
 1. a single submission of multiple responses with feedback to all responses provided at one go either immediately or after a cut-off date (Figure 2)
 2. submission of responses to individual questions with instant feedback (Figure 3).(1 has always been in Moodle; 2 will be in Moodle 2.0).



The screenshot shows a Moodle quiz interface. On the left is a navigation panel titled 'Questions' with a grid of buttons for questions 1 through 8. Questions 1 and 2 are marked with 'i' (answered), question 3 is marked with '3' (in progress), and questions 4 through 8 are blank. Below the grid is an 'End test...' button. The main area shows question 3: 'In an experiment carried out on a fixed amount of gas held at constant volume, the pressure (in units of Pa) was measured as a function of the temperature (°C).' Below the text is a graph with 'pressure / 10⁵ Pa' on the y-axis (0.0 to 2.0) and 'temperature / °C' on the x-axis (0 to 140). A straight line is plotted through the data points. Below the graph, the question asks to 'Estimate the gradient of the resulting graph to two significant figures giving your answer in units of Pa/°C.' A text input field contains the number '350'.

temperature / °C	pressure / 10 ⁵ Pa
0	1.0
40	1.2
80	1.4
120	1.6
140	1.7

Figure 2: OU Moodle in 2008. The new navigation panel and a test configured to accept all answers before any are submitted for marking. Questions 1 and 2 have been answered (but can be revisited) and question 3 is in progress. Questions 4 – 8 have not been attempted.

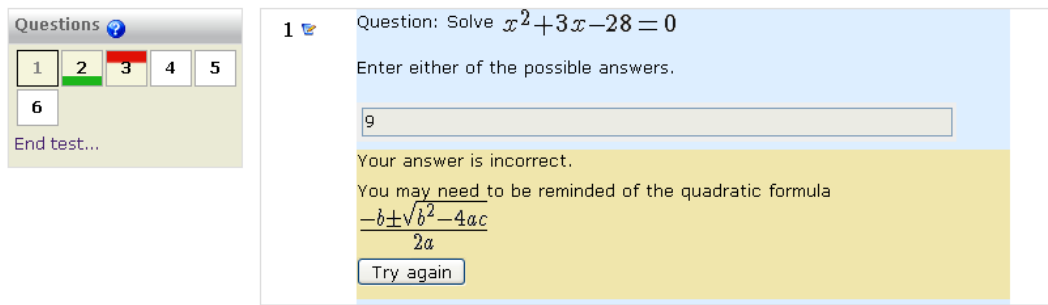


Figure 3: The new navigation panel, a test set up for questions to be answered one-by-one and a Moodle question which allows multiple attempts. This is question 1; the panel shows that that question 2 has already been answered correctly and question 3 incorrectly. Questions 4 – 6 have not been attempted.

- New navigation for the two modes above (Figures 2, 3 and 4) (Moodle 2.0).
- Interfaces to external questions e.g. from OpenMark (Figure 4) (Moodle 2.0) and Stack (developed at Birmingham University) and to external services i.e. the IAT free text server (Figure 1).

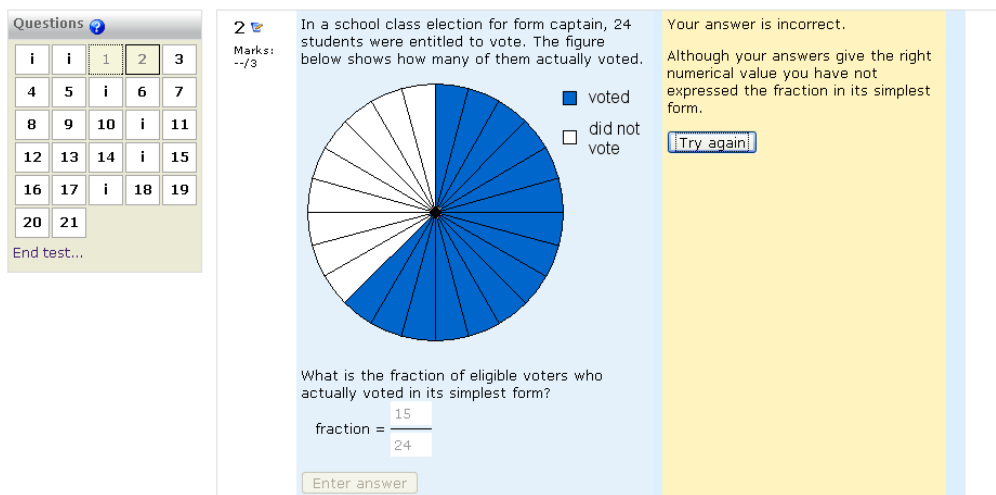


Figure 4: The new navigation panel and an OpenMark question in progress in an assessment that is being run through Moodle.

- Email confirmation on submission of summative assessment (Moodle 1.9). This was designed by the Quiz Maintainer but paid for and implemented in Queensland.
- Support for tutor groups across the Quiz module to reflect OU structures and to ensure that tutors could see the results for only their students (Moodle 1.8).

- Statistical analysis of question and test performance (rewritten for Moodle 2.0).
- Centralised 'Gradebook' reports to students, tutors, course teams and examinations and assessments administrative staff. The Gradebook also accepts data from external systems e.g. OpenMark, and provides links to the university's main student records system (rewritten for Moodle 1.9).

eAssessment demo						
First name / Surname	MU120 icma	A 'CMA style' icMA (constructed entirely in Moodle)	An 'OpenMark style' icMA (constructed entirely in Moodle)	An 'OpenMark style' icMA (constructed in Moodle using OpenMark questions)	An 'OpenMark style' icMA (constructed from a mixture of Moodle and OpenMark questions)	Course total
Range	0 %–100 %	0 %–100 %	0 %–100 %	0 %–100 %	0 %–100 %	0 %–100 %
Sally Davies	-	-	-	-	-	-
Ronald Davies	67 %	60 %	59 %	33 %	58 %	55.43 %
John Davies	-	-	-	-	-	-
Katriona Davies	50 %	40 %	59 %	8 %	13 %	33.87 %
George Davies	89 %	20 %	42 %	33 %	25 %	41.84 %
Group average (Submissions)	69 % (3)	40 % (3)	53 % (3)	25 % (3)	32 % (3)	43.71 % (3)
Overall average (Submissions)	72 % (10)	42 % (11)	62 % (11)	50 % (11)	56 % (11)	55.94 % (11)

Figure 5: The new Gradebook

- A workflow system to monitor the progress of eAssessment production and to automate certain steps. (Although this is in Moodle it will be linked to other OU systems.)

Beyond these specific eAssessment developments we have also relied on other VLE wide developments such as authentication, the development of roles and permissions which are suitable for a large university environment and feeds from our registration system.

Recouping the outlay: usage 2006 – 2008

The latest version of Moodle, Moodle 1.9 has formed the basis of the OU's VLE since January 2008. Prior to Moodle 1.9 we had no link between Moodle and other university assessment related systems and consequently until January 2008 eAssessment in Moodle was restricted to formative and diagnostic eAssessments. Summative assessment was carried out in OpenMark but as the graph below shows the 'VLE effect' of increased publicity and recognition across the university has led to a very large increase in the use of eAssessment from 2006 to 2008.

The graphs below refer to Moodle and OpenMark as separate systems reflecting their status during 2006 – early 2008.

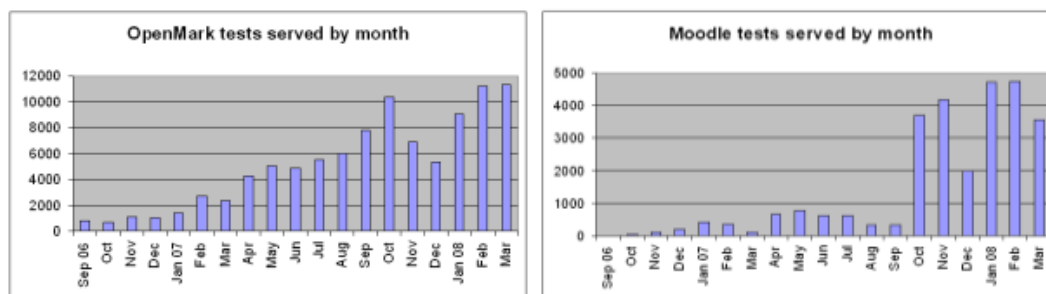


Figure 6:

OpenMark tests to March 2008
Tests served: 97,000

Moodle tests to March 2008
Tests served: 27,000

The figures show total usage by month. For OpenMark this includes diagnostic, formative and summative assessments; for Moodle formative only. Together these systems have now run in excess of 125,000 tests to March 2008. Of these approximately 50% are formative, 40% diagnostic and 10% summative.

It is perhaps worth pointing out that the bulk of the diagnostic tests were taken by prospective students (i.e. the general public) visiting the OU Science website and attempting some of the interactive 'Are you ready for Science?' assessments that the OU provides. We were both surprised and delighted to find that over 40,000 of these tests were served to visitors between May and December 2007.

Beyond the 1800% increase in usage reported above during the period September 2006 to March 2008 two further major steps are about to be taken.

Firstly we have summative tests in Moodle scheduled for June/July 2008. And secondly we have the Moodle - OpenMark interface available enabling OpenMark questions to be included in eAssessments built in Moodle. We anticipate that both will bring further increases in usage in the coming years.

Recouping the outlay: course assessment policies

As the eAssessment systems have grown in stability and visibility we are beginning to see an increasing number of courses following the example of S151 *Maths for Science* (Ross et al, 2006). *Maths for Science* is a short 10 point course that was first presented in 2002. It has been presented four times per year since 2002 with approximately 1,000 students per year. And throughout this period formative and summative course assessment has been carried out through OpenMark. This has been possible because the original questions were constructed with in-built variability so that they could be easily re-used. In 2002 this extra complexity was an up-front load on the production course team, and at the time we questioned whether we would ever recoup the extra effort involved, but after 23 presentations of the course we can now reflect that this was a good investment.

However I should stress that the major driver behind *Maths for Science* choosing to use OpenMark was the desire to give instantaneous targeted feedback to our students as they entered their responses. The course team's intentions were to help students keep on track and to check their knowledge as the course progressed. And now we are seeing other courses use eAssessment primarily for the purposes of helping to pace students through the materials, check their understanding as they go, and we hope, increase course retention.

Gibbs and Simpson (Gibbs and Simpson 2004) suggest a variety of conditions to enable effective assessment of which the first two are

1. Assessed tasks capture sufficient study time and effort.
2. These tasks distribute student effort evenly across topics and weeks.

and two new first level courses have chosen to use eAssessment regularly and often as a means of capturing ongoing student effort to aid pacing and improve retention. SDK125 *Introducing health sciences* and S104 *Exploring Science* have introduced eAssessments to accompany each major block of the course. For SDK125 there is one formative and one summative eAssessment for each of 6 blocks. For S104 there are summative assessments only. In both cases the summative assessments are low stakes and worth a few percent of the total marks. Both courses are new in 2008 and the impact of the eAssessments is being closely monitored.

By March 2008 we have eAssessments in six (of eight) faculties/schools and are aware of plans for further adoption by a variety of new courses.

Summary

The OU now has systems capable of delivering over a hundred thousand tests per annum and in building these systems has made a significant contribution to the development of open source eAssessment systems. Our focus over the coming years will be to spread the use of eAssessment over more faculties, programmes and courses and thereby make a return on our investment.

Our developments are available throughout the world and it is extremely gratifying to read reports describing the growing sophistication of Moodle even when, as is often the case, those reports do not acknowledge the OU's role. From the OU's perspective we are now part of a much larger, world-wide, community with which we can share and discuss ideas and developments. And there is still much to be done.

A Moodle website with demonstrations of many the developments described above can be found on the OU's Open Learn site at <http://labspace.open.ac.uk/course/view.php?id=3484>.

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