Introduction

In order to improve retention on Level 1 Open University mathematics, we are piloting short interactive internet quizzes, using the OU package “Open Mark” This enables students to have several attempts at questions receiving instant teaching feedback, where as previously they had one attempt and waited days or weeks. User feedback on the pilot quizzes suggests that they are enjoyable as well as helpful to student learning.

Background

The UK Open University (OU) supported distance learning undergraduate mathematics programme includes two level 1 course modules: MU120 *Open Mathematics* and MST121 *Using Mathematics*. Several thousand adult students enrol annually on each.

Student internet access has just become compulsorily for administrative purposes and the university is adopting the MOODLE virtual learning environment (VLE). So we are keen to provide academic benefits for those who log on to the OU system. We are also keen to improve retention on these courses (currently around 60%)

MU120 is designed for students who have not studied mathematics for some time and/or who lack confidence. Because its students come with a variety of previous mathematical backgrounds, comprehensive preparatory materials are provided to students, when they register (weeks or months before course start).

MST121 continues on from MU120 but better qualified students will start with this course rather than MU120. It uses the computer algebra package MathCad.

Both MU120 and MST121 are studied over nine to ten months, with students submitting assignments approximately every four to six weeks.

Both MU120 and MST121 currently have a mixture of tutor-marked assignments (TMA), consisting of longish written questions, and multiple choice computer-marked assignments (CMA). Most assignments are summative, i.e. the mark obtained contributes to the final overall mark. However, there is a formative CMA on the preparatory work, which does not contribute to the overall mark.

Both TMAs and CMAs cover several weeks work. Each assignment has a cut-off-date, after which students receive comprehensive feedback on their work. This may be weeks after they have completed the work and probably a month or more after they have studied the earlier topics covered in the assignment.
The usefulness of feedback on assessment

The study of how assessment best supports learning is extensive. Gibbs et al [3] undertook a comprehensive review of the literature in this area and came up with 11 conditions for assessment to best support student learning. The current assessment strategy for MU120 and MST121 satisfies most of them, but falls short on one in particular:

“The feedback is timely in that it is received by students while it still matters to them and in time for them to pay attention to further learning or receive further assistance.” (See [3], p. 172.)

The pilot assessment is designed to rectify this. Internet quizzes give speedy feedback, at points where students would pay attention to it and use it in their learning. Brookhart [1] discusses the differences between formative and summative assessment and Yorke [7] discusses the role of formative assessment in retention in Higher Education. For the pilots, formative assessment was chosen to aid student retention. Buchanan [2] emphasizes the role of feedback in fostering a meaningful interaction between student and the teaching materials, with particular emphasis on the use of web-based formative assessment. The OU’s developing web-based science assessment system “Open Mark”, was adapted for the pilot mathematics quizzes, as it fosters such interactions.

E-assessment using “Open Mark”

“Open Mark” is an on-line interactive assessment system, which has been developed over a number of years, as outlined in Ross, Jordan and Butcher [6]. It aims to provide feedback to students, which is instantaneous, targeted and detailed.

Traditionally, the OU has used multiple choice questions in CMAs, but “Open Mark” has broadened the range of question types, thus enabling more skills to be assessed and making the assessment more interesting for students. Question types which enable plotting of points and lines on graphs, matching pairs, dragging and dropping words or symbols into appropriate places in mathematical expressions or text are available, as well as multiple choice and entering of numerical and algebraic answers. “Open Mark” is being integrated into the MOODLE VLE and so is Open Source.

“Open Mark” enables mathematical expressions to be entered easily and equivalent mathematical expressions are recognised as equally correct. Most questions can be designed in several variants that are randomly selected. Students are allowed multiple attempts at each question (the maximum score diminishing with each attempt). They receive feedback after each attempt, tailored to their actual answer. The feedback after the final attempt usually includes a full worked solution or equivalent. We have also introduced a “hint” option, to help those, who don’t know how to approach a question.

Examples of question feedback are: pointing out standard errors; telling the student if their answer is too large or too small; showing which parts of a multi-part answer are correct; and giving them hints. The feedback after the successive attempts often gives progressively more detailed hints. Details of the feedback mechanisms are given in Jordan, Butcher and Ross [4], together with some of the technical aspects of the “Open Mark” system. There is a demonstration web-site showing different types of question and feedback at http://www.open.ac.uk/openmarkexamples.

Upon completing each “Open Mark” assessment, students receive their marks and some appropriate study advice. References to the appropriate sections of the teaching materials are given, enabling them to quickly check on areas which need more attention.

A useful feature of “Open Mark” is the administrator’s reports, which show all responses for all users and question statistics. This can be used on an individual level and on a macro-level to analyse responses, identify questions, where improvements might be needed.

The pilot mathematics “Open Mark” quizzes

For both courses, the principle is to provide short quizzes on coherent units of work. Students access the quizzes from their “Student home-page”. In order to explore the outcomes from different uses of “Open Mark”, the approach for MU120 and MST121 quizzes is different.

Each (formative) MU120 quiz is based upon the one of the eight topics in the preparatory materials and has about six questions. The quizzes aim to help students assess their progress on a topic, as they complete it, at regular intervals, and to motivate them to continue with their studies. The quizzes use a variety of “Open Mark” question types, selected to best assess each skill. Students can attempt the quizzes as many times as they wish – the questions will be slightly different each time. Hence those who register well before the course start, will have plenty to keep them involved, whereas those who register close to course start might attempt the quizzes just once in order to check their understanding.

The MST121 quizzes are designed to give the students practice in answering the type of questions on the summative CMAs; so questions are multiple choice. Students may tackle the quizzes throughout the course, after each chapter, and also use them in their revision for the final consolidation assignment.

Current readers can try the MU120 quizzes themselves on the web-link: http://mcs.open.ac.uk/mu120/. The MST121 quizzes start with the web-link https://students.open.ac.uk/openmark/mst121.chaptera0/ and successive
quizzes can be accessed from here or by replacing a0 by the
chapter number (a, b, c 1 to 3)

Questions and feedback

The questions are designed to test specific skills and
the feedback tailored to specific standard errors or
misconceptions. There is also a generic feedback for other
incorrect answers. This often gives a hint as to why the
answer is wrong and reminds students of the technique.

The feedback on correct responses always includes some
working. However, there is often some additional teaching
in the feedback for correct responses, as well as for incorrect
responses e.g. an alternative method may be given.

The feedback on incorrect responses may be designed to
make a student do some work, as in Fig 1 below, which
shows the feedback for a "drag and drop" question, in
which the student has correctly dragged and dropped
five definitions next to the relevant symbols, but has not
attempted the other five.

Your answer is incorrect.
5 correct selections were made.
Try again and correct those that
are wrong or incomplete.

Note the following correct use of
the symbols which you got wrong:
3 \times 3
4 \times 4
3+2 = 9
1/3 = 0.33333
3 \div 4

[Table]

<table>
<thead>
<tr>
<th>Mathematical symbol</th>
<th>definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>(=)</td>
<td>Is equal to</td>
</tr>
<tr>
<td>(\geq)</td>
<td>Square root</td>
</tr>
<tr>
<td>(&gt;)</td>
<td>Is greater than</td>
</tr>
<tr>
<td>(&lt;)</td>
<td>Is less than</td>
</tr>
<tr>
<td>(\times)</td>
<td>Multiply by</td>
</tr>
</tbody>
</table>

Fig 1 – Feedback on an incorrect response

At the end of each quiz, students get a feedback page,
which contains a summary of their performance, with an
appropriate study comment, and a list of relevant references.
The feedback page also gives students the opportunity to
repeat the quiz with slightly different questions. They can
repeat which ever question types they choose.

Feedback from authors

The initial authoring of questions takes a similar amount
of time to writing conventional multiple choice CMA
questions. However, because the feedback is more
detailed and targeted, it takes longer to author. At the
moment, the questions have to be programmed into the"Open Mark" system by somebody familiar with Java and
so this is an additional resource, replacing publishing
resource for print based assessment. Similar proof-
reading is required for electronic and print, but because
the feedback is more extensive, checking the interactive
internet quizzes takes longer.

After the first user trials, the questions and their feedback
were improved. This is an additional stage. However the
finished product is much better than a conventional CMA.

Another bonus is that, by including the variation facilities
in "Open Mark", one question is actually a set of similar
questions, which lessens the need for further work in
future years.

Individual students can be tracked on the administrative
reports, which list all students who have attempted each
quiz, their time on-line, all their responses and scores.
The reports can also highlight problems. For example, the
question score summary statistics sometimes highlighted
a problem with a particular question and closer inspection
found that the question or the initial teaching feedback on
the question could be much improved. The reports can also
be used for analysing student errors as in Jordon [5], but
this is quite a lengthy project.

Feedback from users

At the end of each pilot MU120 quiz, there was a brief
feedback question. These provided invaluable information
on possible improvements. In addition the quizzes were
evaluated using actual student users “thinking aloud” as
they complete the quizzes. The resulting videos are being
analysed to see how the quiz questions and feedback
stimulate their learning.

In some cases, opportunities for improving the quizzes
were seen from the video. For example, in a scientific
notation question, a student missed out one of the two
60s in the calculation of the number of seconds in January
and so the feedback was not useful to the student, as this
error was not anticipated.

From the administrator reports, the feedback questions,
and from the “thinking aloud” videos, it seems that users
generally take between 5 to 30 minutes per quiz (less
time on the earlier quizzes and more on the later ones as
anticipated). They generally like the immediate targeted
feedback. However, they are then critical, when the
feedback is less specific to their answer. After the initial
trials, it was sometimes possible to improve the feedback,
but it is not always possible to anticipate every error.

The “thinking aloud” videos showed that the quizzes
stimulate much learning. Students look up the relevant
references, work on paper and use their calculators. They
spend as much time on other media as they do studying
from the computer. They usually read the feedback carefully
even if they got the question correct. The students said that
the quizzes stimulated their learning more than just doing
exercises “from a book”. One remarked that you had to do
the questions for real – you couldn’t cheat by looking up
the answer in the back of the book. If they got stuck or went
wrong, they generally got more useful timely feedback
from the quizzes, relevant to their actual answers. Students
reported that they enjoyed the interactive quizzes, as well
as finding them useful in checking their understanding and
stimulating their learning. From the ‘thinking aloud’ videos,
it appears that students are not so keen on multiple choice
questions and their strategy is different in answering these questions. They are less likely to actually do the work and more likely to make intelligent guesses. They like questions where they type in the answer, match pairs or other drag and drop.

Future work

It is hoped to do further analysis of the administrative reports and the “thinking aloud” videos. An aim is to examine how different types of question and feedback stimulate learning, highlighting relevant aspects for future authors. The assessments themselves can be improved and the results of the project used by course teams for new and rewritten course modules. In particular, the rewrite of MU120 is just underway and the course team plans to use Open Mark assessment.

After the end of this year’s presentations, the retention rates of MU120 and MST121 students using the quizzes will be compared with those who do not use them.

By the summer of 2008, the MU120 preparatory materials, together with the corresponding Open Mark quizzes, will be available on the OU’s Open Learn web-site, for all to use. In particular, people contemplating registering for the course will be able to study the preparatory material in their own time beforehand and receive helpful tailored feedback on the attempts at the quizzes.

Conclusion

The “Open Mark” system has enabled us to successfully pilot the use of interactive internet assessment with OU level 1 mathematics students, to make feedback more immediate and useful within student learning. Initial user trials suggest that students find the quizzes fun as well as useful for their learning. They like the more immediate tailored feedback and the shorter assessments – one on each topic. Authoring of quizzes is more time-consuming initially than the traditional CMAs, but less work subsequently.

It is hoped that the increased motivation and improved feedback will lead to better student retention but this can only be judged after course end.

The pilots have stimulated discussion of mathematics assessment and much of interest in the Faculty. It has provided a stimulus for course teams to use the internet and the new MOODLE VLE to improve our assessment and teaching.

References


