Report on the trial of electronic tutor-marked assignments on mathematics and statistics courses in 2008

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Summary

Background
Electronic assessment is growing rapidly in the Higher Education sector, and in the UK Open University (OU) in particular, however, e-assessment in mathematics and other symbolically rich subjects involves particular challenges. Whilst there is a growing body of work on automatic marking of mathematics using computer algebra, such systems are limited in their handling of sophisticated mathematical argument, and nor do they provide the level of feedback associated with quality correspondence tuition. This report evaluates an approach to electronic submission and personalised marking of mathematics and statistics assignments.

Research context
At the OU many students benefit from electronic submission of tutor-marked assignments (eTMAs), which facilitates prompt return of feedback. However, in mathematics, and other symbolically rich disciplines, paper-based submission has been preferred due to difficulties in electronic preparation and subsequent marking of notation and diagrams.

In the interests of access and widening participation it is considered important that students have free choice in how they prepare their eTMAs and are not required to significantly alter their practices from paper-based work. However, recent technological developments have opened up possibilities for tutors to annotate mathematics eTMAs submitted in a variety of document formats.

Methodology
In 2008 a nine-month trial was conducted with a group of 24 tutors covering thirteen mathematics and statistics courses. Students’ submitted assignments were converted to Word 2007 before being delivered to the University’s standard eTMA system. From there students’ work was collected, marked and returned by the tutor, and marks recorded, in accordance with standard procedures.

Tutors who volunteered for the trial had all expressed an interest in developments in e-learning, and were typically highly experienced and dedicated. Although the tutors were not necessarily experienced in typesetting mathematics, it was thought reasonable for them to acquire such skills and, indeed, one element of the trial was to ascertain the feasibility of using Word 2007.

Tutors received two types of Word 2007 file: those consisting of embedded images of students’ work; and those containing editable text. Depending on the document type, the tutors could choose how to best give feedback using their preferred mix of direct typing, commenting facilities in Word 2007, superimposed textboxes and inking.

The tutors received a small remuneration in recognition of time spent to accustom themselves to the technologies, and to provide feedback on their experiences. A quarter of the tutors had previous experience of processing, handling and marking eTMAs (in another subject area).

Students of the participating tutors were advised of the option to submit assignments electronically. Information, including full instructions for preparing and submitting eTMAs, was delivered via their tutor. Some students, especially those studying mathematics alongside another curriculum area, had experience of eTMAs on other courses.

The trial ran for the duration of each course, though the number of assignments that could be submitted electronically ranged from two to six, depending on the nature and credit-rating of the individual course. All students had the option of submitting a test eTMA.
Evaluation
The trial was evaluated through the following four strands.

- Interrogation of the eTMA systems for quantification of the number and types of submissions.
- Collection of tutors’ perceptions of the technological, pedagogic and affective aspects of eTMAs, through formal questionnaires and from comments to an online conference. Three formal surveys were conducted to give a longitudinal study of the extent to which perspectives changed.
- Collection of students’ perceptions of the preparation, submission and value of mathematics eTMAs, through a formal questionnaire at the end of the trial. Students who had chosen to submit eTMAs, and those who had not, were surveyed.
- Scrutiny of marked eTMAs from each tutor and comparison with their annotations on paper submissions.

Main findings
Student’s perspective
On average about 20% of students in the participating groups choose to submit their TMAs electronically. About half of these submitted all, or all but one, of their eTMAs electronically, and students on statistics courses were most likely to submit eTMAs.

The main reasons students gave for not engaging with eTMAs on their maths courses were, firstly, that typesetting maths was inconvenient or not preferable pedagogically, and, secondly, that paper submission was more convenient or quicker. However, about 40% of these students said that they would consider submitting eTMAs on future maths courses if given the chance to do so.

Students submitted a wide variety of file types for their maths eTMAs, with PDF being the most popular choice, closely followed by Word (pre-2007). Just over 15% were submitted in Word 2007, and a similar number were image files. However, just over half of the students used Word (Word 2007 or a previous version) to prepare their submissions. Just over 30% produced their work by hand, rising to nearly 50% for diagrams.

Generally students found their chosen method for preparing their maths eTMAs to be straightforward, although 36% felt that it took longer than preparing a TMA for paper submission. Well over 40% said that they submitted their eTMAs later than they would paper TMAs and, indeed, a similar number submitted eTMAs on the cut-off date, or just one day beforehand.

The vast majority of students found the maths eTMA submission process to be easy and convenient to use, and the most common response to the question about how it might be improved was ‘none’. However, quite a few students wanted to be able to use the OU’s main eTMA system or, at least, would prefer a web-based route. The desire to submit larger files was also a common comment.

The students were generally very pleased with what they received in their returned, marked eTMAs, although there were a few issues with formatting. The reactions to questions about the quantity, legibility and helpfulness of tutors’ comments were all extremely positive, and there were hardly any suggestions that tutors’ electronically-generated comments were seen as less personalised.

To summarise the positive aspects, students found the submission of maths eTMAs to be convenient, reliable and reassuring in the sense of knowing that the TMA has got to the tutor. Students appreciated the faster turn-round, and the facility to submit closer to the deadline, if needed. Some students commented on the benefits of electronic storage, and the consequential reduced use of paper. A few students said that preparing maths eTMAs had been of educational value in itself.
Where students cited negative aspects, these were primarily to do with the difficulty of typesetting mathematical notation, and the associated additional time required. A few mentioned that the submission process was rather cumbersome, or that the restricted file size had been a nuisance.

Almost all the students said that they would submit maths TMAs electronically again if possible. If they were to change anything to do so, it would most likely be to take the opportunity to invest in, or to improve their skills in using, software which facilitates typesetting of mathematical notation.

Of the 40 students who responded to the explicit questions about Word 2007, opinions were split on recommending its use to other maths students: about 75% would, but the rest definitely wouldn’t.

During the trial remarkably few students contacted the maths eTMA team with queries. The most frequent query was about compressing files to an acceptable size. A number of other queries arose because students were trying to submit eTMAs directly to the main eTMA system.

**Tutor’s perspective**

On average tutors marked just over twenty eTMAs each and almost all reported, throughout the trial, that marking took considerably longer than for the equivalent paper TMAs. Factors which affect the time actually spent marking included: positioning textboxes, inserting ticks and marks within textboxes and switching between typesetting and inking. Such factors interrupt the flow of thought in marking. Those using exclusively typesetting or inking experienced less difference in marking times, although still reported that e-marking took longer than paper marking.

Initially tutors’ concerns focussed on difficulties in using the OU’s main eTMA system, in particular in returning marked eTMAs. Although these decreased with practice, the added complexity of dealing with multiple files and formats remained a concern throughout. Specifically, working with a mix of embedded images and editable Word 2007 documents affected tutors’ confidence in dealing with eTMAs, even for those with prior experience of using the eTMA system.

The majority found handling and marking eTMAs less convenient and less flexible than marking paper TMAs. Seventy percent found marking eTMAs more stressful due to the complexity of interacting with multiple systems (eTMA, FileHandler), applications (Word, PDF convertor, etc), file formats, marking approaches, and so on.

Each tutor developed an individual approach to e-marking. For example, some used exclusively inking, and some used direct typing within the student’s work. However, most used a mix of the tools available to them, even within a single assignment. The choice of approach depended on a number of factors such as: the tutor’s ICT experience and computer configuration; the tutor’s preferred marking style on paper; the format of the student’s assignment; the academic requirements of the course.

There was no overall preference between editable eTMAs and those consisting of embedded images. However, over half of individual tutors did express a preference for one or the other. For many of the tutors a different approach had to be adopted for each of these document types.

There were some issues concerning the robustness of Word 2007 which appeared to be due, at least in part, to the type of computer and / or operating system used by the tutor. The mathematical facilities of Word 2007 were used by over half the tutors and generally considered useful. The MOL-developed add-in marking tools were found to be more useful on editable documents. However, they were not widely used, primarily due to stability issues.

Those with access to reliable inking hardware and software (for example, those with a Tablet PC) found this approach helpful. However the small plug-in graphics tablet was not rated highly, in part because the images it produced were too crude to be really effective for teaching.

No simple solution to the problem of how tutors might create and insert diagrams was found. Some tutors drew diagrams on paper, scanned and inserted them into the eTMA. However, where
possible and appropriate, tutors chose to cut and paste diagrams from the tutor notes. Many tutors requested that course teams provide electronic versions of diagrams for easy insertion into eTMAs.

All the tutors invested significant time and effort in order to match the quality and quantity of the feedback they are accustomed to giving on paper TMAs. This was true for the number of comments, length of comments and the helpfulness of comments. However, by midway through the trial, tutors felt that the quality of their feedback to students was starting to be compromised. Tutors reported greater recycling of comments and use of pre-prepared feedback, accompanied by a reduction in the number of spontaneous comments and in the personalisation of feedback to students. Some tutors even omitted ticks in order to save time.

There is evidence of greater re-use of comments by tutors receiving a larger number of eTMAs. However, tutors recognised that such recycling potentially reduces personalisation, with the concern that students perceive comments to be generic. However, when typesetting, the ease of re-editing previously-used comments and to correct one’s own errors was appreciated.

Tutors regard the facility for students to submit a dummy TMA as very useful. Not least because, due to the huge variety of file types that can be submitted, it is important that students can check that their processed work is likely to arrive with the tutor in an acceptable state.

The supporting documentation provided to tutors was generally appreciated, although not used extensively. Online training was well received because specific tools could be demonstrated. The online conference was useful for some, but tutors had different expectations of its purpose.

As was the case for students, in the main, the positive aspects of eTMAs cited by tutors related to the benefits of eTMAs in general, whereas the negative aspects were more much more likely to relate specifically to maths eTMAs.

**Introduction**

For 40 years, the OU has been the premier distance learning university in the UK. With its unique ‘supported open learning’ approach, combining high quality, well-designed self-study materials with individual and group support through a network of part-time associate lecturers (known as ALs or as tutors), the University attracts 200,000 part-time students working towards undergraduate and postgraduate qualifications ranging from entry level through to master’s and doctoral level.

There are approximately 15,000 students registered on OU mathematics courses, and each student is supported by a part-time tutor, for each course of study undertaken. In many cases, a tutor may live some distance from individuals in their tutor group of about 20 students, and may even reside in a different country. A key component of the OU’s teaching model is the tutor-marked assignment (TMA). These are assessed pieces of course work undertaken by the student at regular points in each course, and marked by their assigned tutor. Typically, a 30-point course contains 4 TMAs and a 60-point course 7 TMAs. The students’ results on these usually form a substantial part of the course’s summative assessment, and the tutors also provide ‘correspondence tuition’ (McDonnell & Wood, 2004) in the form of extensive individualised feedback on methods and misconceptions (Rowe [1] & Wood, 2008). For many students this is their only source of personalised tuition (Rowe [2], Wood, & Petocz, 2008) and, in that sense, the OU’s requirements differ from the e-marking systems used for public examinations (Assessment and Qualifications Alliance (AQA)).

Annually 85,000 mathematics TMAs are submitted and returned, almost all by post. This is slow and expensive (due to multiple handling), and it hinders the expansion of the University’s mathematics offerings to a wider audience, not least because delayed feedback is of much less use to students (Gibbs & Simpson, 2004), (Chickering [1] & Gamson, 1987), (Chickering [2] & Gamson, 1991).

Many parts of the OU use electronic submission of TMAs (known as eTMAs), though mathematics and other symbolically rich disciplines have tended to retain postal submission, largely because of
the difficulties in electronic submission and marking of mathematical material. However, recent technological developments have opened up possibilities for tutors to annotate mathematics eTMAs submitted in a variety of document formats. Other trials in similar curriculum areas, both at the OU (Freake, 2008), (Underwood & Freake, 2007), (Fisher [1], 2008), (Fisher [2], 2008) and elsewhere (McLaughlin, Kerr, & Howie, 2007), (Steinweg, Williams, & Warren, 2006) have adopted a hardware approach through the provision of Tablet PCs to facilitate ‘correspondence’ tuition via digital inking. The maths eTMA trial sought a more cost-effective solution which could be rolled-out to over 500 UK OU mathematics tutors. Microsoft Word 2007 was chosen as the principal tool because of its facility to produce professional-quality typeset mathematical notation (Sargent, 2009). It supports both typed and inked annotations, although third-party software is needed to enable inking on non-Tablet PCs. These facilities were augmented by tools developed in-house to allow manipulation of embedded images of handwritten work and insertion of pre-prepared comments, ticks and marks. There have also been other software based approaches (for example, (Denton, Madden, Roberts, & Rowe, 2008)) in which feedback is emailed directly to the student, separately from the student’s work. However, for OU maths students it was felt that annotation of their work was imperative in providing good quality feedback (Steinweg et al, 2006) and Word 2007 potentially facilitated this.

Following a small pilot trial of electronic marking (but not of electronic submission) of maths eTMAs in summer 2007 (Mestel, Lowe, & Arrowsmith, 2008), it was decided to run a trial encompassing full electronic submission and return of assignments across as wide a range of maths courses as possible. This larger-scale trial ran for the duration of the February to October 2008 presentation of taught courses, from entry level to master’s level, in pure and applied mathematics and statistics.

Methodology of the trial

Principles

The basic principle of the maths eTMA system (Lowe, Mestel, & Arrowsmith, 2008), developed initially specifically for the trial, is that students should have relative freedom in terms of how they prepare their eTMAs, and not need to alter significantly their method used to produce their work from that used for paper submission. Whilst some students already use a variety of systems to word-process mathematical assignments, many prefer to handwrite their solutions. Indeed, there are pedagogic advantages to the latter (Anthony, Yang, & Koedinger, 2008), and consequently submission of digitally scanned handwritten pages, for example, is permitted. It is generally inappropriate to expect students who are learning mathematics to learn simultaneously how to typeset mathematical notation, especially those who are on lower level courses and / or who are studying some mathematics to support another curriculum area. In addition it is not appropriate to tie a student to using particular hardware or software, to which they might not readily have access.

Similarly, since of necessity, the equipment available to tutors varies, as do their marking preferences, a range of approaches to marking of maths eTMAs should be supported. Moreover, tutors should not require different software to accommodate student work in a variety of formats. On the other hand, tutors are contractually expected to have a certain level of proficiency with information technology and to have access to a computer running a recent version of the Microsoft Windows operating system, the main system supported by the University. The maths eTMA system should therefore permit tutors to mark mathematics TMAs using whatever hardware is available to them. However, it was felt reasonable to expect tutors on the trial to receive eTMAs as Word 2007 documents and to use the features therein and / or add-on inking tools to mark maths assignments. Indeed, the evaluation of the use of this software is one reason for running the trial.

Finally, the trial was designed so that processing of maths eTMAs would integrate with the OU’s main eTMA system and conform to standard practices as far as possible, without requiring re-development of that system. It was also desirable for the tutors and students to make as much use of the main eTMA system as possible, and essential with respect to the recording of marks awarded.
Recruitment of tutors

In the second half of 2007 a number of tutors were invited to participate in the maths eTMA trial to be run on courses presented in 2008. The invited tutors primarily came from two groups. About half a dozen had been involved in a small ‘proof of concept’ maths e-marking trial in summer 2007. The others had attended a regional or central staff development event in the recent past and had expressed an interest in e-learning developments in maths and / or in the MOL project. About 30 tutors volunteered to take part in the trial and, after ensuring that there would be a spread of groups across the mathematics and statistics curriculum, 24 were eventually contracted\(^1\). In general the tutors who come forward to participate were very experienced in teaching with the OU and in supporting students. For many the OU is their main source of employment, and thus they had the time and inclination to work on the trial, and thus may be described as ‘early adopters’ (Kirkup & Kirkwood, 2005). A few of the tutors were very computer literate and / or had experience from other courses of marking eTMAs. However, most had no knowledge of the OU’s main eTMA system and some, by their own acknowledgement, would describe themselves as technophobes or as not very proficient with, for example, MS Word.

The participating tutors were contracted to:

- install Office 2007 and, optionally, inking tools and / or the MOL-developed marking tools on their own PC;
- read the specially prepared training / supporting documentation and participate in (online) training events;
- forward documentation about the trial to their tutor group(s), and support and encourage students in the preparation and submission of maths eTMAs;
- mark maths eTMAs using any combination of the Word 2007 / inking tools / MOL marking tools according to their personal preference;
- provide feedback on their experiences and contribute to the formal evaluation of the trial.

The tutors were supplied with Microsoft Office 2007 and, optionally, a small (10cm) graphics tablet (manufactured by Wacom) with stylus pen to facilitate digital inking. Four tutors were using Tablet PCs. Tutors had the option of downloading inking software, the cost of which was reimbursed. Those who needed them were also provided with headsets in order to facilitate online training. Documentation and training covering the various marking and annotation tools and facilities was provided and an online support conference set up. The tutors were paid £500 each.

About half way through the trial it was noticed that one or two tutors had received significantly fewer eTMAs than average. These tutors were asked to contact all their students again in order to encourage them to submit electronically.

Courses in the trial

<table>
<thead>
<tr>
<th>Course code</th>
<th>Title</th>
<th>Number of eTMAs permitted on trial(^*) excluding TMA00</th>
<th>Level and category</th>
<th>Number of tutor groups in trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>MU120 30</td>
<td>Open mathematics</td>
<td>2</td>
<td>Undergraduate Level 1 General</td>
<td>2</td>
</tr>
<tr>
<td>MST121 30</td>
<td>Using mathematics</td>
<td>3</td>
<td>Undergraduate Level 1 General</td>
<td>2</td>
</tr>
<tr>
<td>MS221 30</td>
<td>Exploring mathematics</td>
<td>4</td>
<td>Undergraduate Level 2 General</td>
<td>8</td>
</tr>
</tbody>
</table>

\(^1\) One of the tutors on the trial is also a member of the non-AL staff, and did not receive a separate contract for participating in the trial.
<table>
<thead>
<tr>
<th>Course code</th>
<th>Credit points</th>
<th>Title</th>
<th>Number of eTMAs permitted on trial* excluding TMA00</th>
<th>Level and category</th>
<th>Number of tutor groups in trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>M208</td>
<td>60</td>
<td><em>Pure mathematics</em></td>
<td>6</td>
<td>Undergraduate Level 2 Pure</td>
<td>5</td>
</tr>
<tr>
<td>MST209</td>
<td>60</td>
<td><em>Mathematical methods and models</em></td>
<td>6</td>
<td>Undergraduate Level 2 Applied</td>
<td>5</td>
</tr>
<tr>
<td>M248</td>
<td>30</td>
<td><em>Analysing data</em></td>
<td>4</td>
<td>Undergraduate Level 2 Statistics</td>
<td>4</td>
</tr>
<tr>
<td>M249</td>
<td>30</td>
<td><em>Practical modern statistics</em></td>
<td>3</td>
<td>Undergraduate Level 2 Statistics</td>
<td>2</td>
</tr>
<tr>
<td>MS324</td>
<td>30</td>
<td><em>Waves, diffusion and variational principles</em></td>
<td>4</td>
<td>Undergraduate Level 3 Applied</td>
<td>2</td>
</tr>
<tr>
<td>MS325</td>
<td>30</td>
<td><em>Computer algebra, chaos and simulations</em></td>
<td>3</td>
<td>Undergraduate Level 3 Applied</td>
<td>3</td>
</tr>
<tr>
<td>M338</td>
<td>30</td>
<td><em>Topology</em></td>
<td>4</td>
<td>Undergraduate Level 3 Pure</td>
<td>2</td>
</tr>
<tr>
<td>M820</td>
<td>30</td>
<td><em>Calculus of variations and advanced calculus</em></td>
<td>4</td>
<td>Postgraduate Applied</td>
<td>4</td>
</tr>
<tr>
<td>M821</td>
<td>30</td>
<td><em>Non-linear ordinary differential equations</em></td>
<td>4</td>
<td>Postgraduate Applied</td>
<td>1</td>
</tr>
<tr>
<td>M823</td>
<td>30</td>
<td><em>Analytic number theory</em></td>
<td>4</td>
<td>Postgraduate Pure</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Total = 41</strong></td>
<td></td>
</tr>
</tbody>
</table>

* This is the maximum number of assignments each student on that course could submit excluding the test eTMA (TMA00). TMA01 for MU120, MST121, M208, MST209, M249 and MS325 was excluded from the trial because it is a split TMA (whereby students submit half the work for the TMA soon after the course starts in order to receive early feedback). MU120 TMA04 was also excluded from the trial, as its cut-off date was significantly later than the final TMAs on the other courses.

**Students**

Each participating tutor sent their own students a centrally-written brief about the trial at the beginning of the course presentation. Students had no prior knowledge that their course or tutor would be involved in the trial. Those who might wish to submit eTMAs on their maths course(s) were asked to inform their tutor, who would then provide a copy of the ‘Student Guide to Maths eTMAs’. This document is similar to the University’s standard student eTMA guide, but details the differences in the types of files that can be submitted and, most importantly, the special submission procedures. Some tutors chose to send the ‘Student Guide to Maths eTMAs’ to all the students in their group(s), thus the number and identity of students who might submit eTMAs was not necessarily known to the tutor in advance of submission, and certainly not to the MOL team.

The OU Computing Helpdesk and the Assignment Handling enquiry teams were briefed about the trial, but there were only one or two queries from students to either of them during the trial.

Students were advised that they could contact a maths-etma-help mailbox if they encountered any problems in the preparation and, particularly, the submission of an eTMA. In addition, a little way
into the trial, an online conference was set up for all the students in the participating groups. There were no more than twenty messages in total to the mailbox, and not many more in the conference.

About a third of the way through the trial the tutors were asked to contact their group(s) to offer a copy of the MOL-produced ‘Guide to using the mathematical features of Word 2007’. It had been observed that some students who were using Word 2007 weren’t using it for mathematical notation, so the guide was designed to assist them as well as, possibly, to encourage a few more to consider submitting eTMAs.

Training and support for tutors
The tutors were provided with the following documentation, mostly at the start of the trial.

- Outline of the trial and associated arrangements and procedures
- Contractual brief
- Standard tutor guide to the eTMA system
- Supplement to the guide to the eTMA system (to explain the differences for maths eTMAs).
- Guidance on how to install Office 2007, how to obtain inking tools and how to access Elllluminate (for online training sessions)
- Quick guide to using Word 2007 for Maths eTMAs*
- Guide on how to use Word 2007 for marking maths eTMAs
- Student Guide to Maths eTMAs (to pass onto students, and for their own reference)
- Guide to installing and using the MOL marking tools (when these became available)
- Guide to using the mathematical features of Word 2007 (to pass to students and own use)

* The Quick Guide was intended to help tutors make a quick start to maths eTMA by using the approach of one tutor (SC) who had been on the previous e-marking mini-trial. It referred to the main guide on using Word 2007 for marking maths eTMAs for those who wanted more detail. The Quick Guide emphasised the difference of approach required for Word 2007 documents containing embedded images as opposed to those containing editable text.

Tutors who were new to using the OU’s eTMA system were asked to use the standard online training, and to take advantage of any relevant training offered by their Region. Some of the tutors who were new to handling eTMAs had cause to contact the OU Computing Helpdesk for assistance.

The tutors all participated in two online training events specifically for maths eTMAs. The first of these, held late January/early February, covered the maths eTMA process, the types of documents they could expect to receive, and useful features of Word 2007 for marking, such as textboxes/callouts, and input of mathematical notation. A follow-up session about two weeks later focussed on using the MOL marking tools within Word 2007 and, briefly, on inking tools.

Once all the tutors were contracted onto the trial, they were given access to dedicated online conference. This was used to provide back-up copies of all the documentation, send out notices, and for tutors to share problems, difficulties, tips and successes. Later the conference was also used to collect semi-formal feedback from tutors about their experiences, in the form of regular reports. In an ‘emergency’ tutors could contact members of the MOL team via the maths-etma-help mailbox, or via personal email messages.

A third online training session was held to introduce some tutors to a second version of the MOL marking tools. In the end the tools were not sufficiently stable to issue to tutors, although those who attended could see the improvements they potentially offered compared to the first version.

The University’s Assessment Policy area made a special dispensation so that maths eTMAs would not be part of the standard selection for monitoring purposes. This was partly for pragmatic reasons, and partly because tutors’ work would be scrutinised as part of the trial evaluation (albeit not by a Staff Tutor or fellow course tutor). Two or three tutors asked if their eTMAs were being monitored, and one commented that it would have been helpful to receive a monitoring report on her eTMAs.
The maths eTMA process

The workflow for maths eTMAs is illustrated as follows.

The standard web-based submission route to the OU's main eTMA system is disabled for the courses in the trial. Instead the students email their work as a single file, zipped as necessary, to the maths-etma mailbox. The student puts their student number, course code and TMA number in the subject heading of the email, and this information is later forwarded with the processed files to the OU’s eTMA system to be validated and recorded.

The mathematics eTMA system permits students to submit work in a variety of document formats including Word 2003 (doc), Word 2007 (docx), digital images (jpg, png, gif, bmp etc) (arising from, for example, scanned pages of handwritten work) or as PDF. PDF files might be generated using, for example, LaTeX, OpenOffice, or any other word processor; or might again contain images of scanned handwriting. The student uses email to submit files to the maths eTMA pre-processor which automatically produces Word 2007 documents as follows.

- Image files (jpg, png, gif, bmp etc) are inserted one image per page into the Word document, and locked to prevent accidental deletion during marking.
- Each page of a PDF file is converted to an image using the open source software package ImageMagick (ImageMagick, 2008) and then formed into a Word 2007 document as above.
- Word 2003 documents are translated to Word 2007 format using Microsoft’s Office File Converter (OFC) (Microsoft Office Migration Planning Manager, 2008).
- Word 2007 documents are unchanged.
- Other files, such as worksheets from mathematical packages (Mathcad, Maple etc.) or computer code, where required, are unchanged.

In all cases bar the last two, a header is added to the document indicating the format of the original submission and reminding the tutor to return the marked file in PDF format since it cannot be assumed the student has Word 2007 to enable them to read the marked script.

The processed documents are forwarded automatically to the OU’s main eTMA system by email on behalf of the student. This system normally imposes a file-size limit of 2Mb per eTMA submission, which was increased to 3Mb for maths eTMAs. Due to the size of digital image files, it was possible that a student’s submission in the trial might exceed this limit. In this case, the mathematics pre-

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2 Save as PDF functionality for Word 2007 is provided by a freely available Microsoft plug-in. There are also free downloadable packages which convert documents to PDF.

3 A Word 2007 viewer for Windows operating system is available, but this renders any mathematics input using Word 2007 as low quality images, thus removing the mathematical typesetting advantages of Word 2007.
processor decreases the size of the file by reducing the resolution of the image and / or reducing the number of colours used within it. In all cases, when the processed submission is forwarded to the University system, a copy is sent to the student. If dissatisfied with the processed result, the student has the option to amend their submission in an appropriate way and to re-submit.

Tutors access and download the submitted script from the OU’s web-based eTMA system in the standard way as those on other OU courses. Return of marked scripts is via the same system.

**Microsoft Word 2007**

Word 2007 was chosen as the principal marking tool because of its built-in annotation and mathematical tools, and because it supports both typed comments and annotations, and the use of digital ink technology. Specifically Word 2007 has:

- dual input modes: an easy-to-use graphical user interface (GUI) integrated with a LaTeX-style linear input syntax mode;
- easy toggle between mathematics and normal text input modes;
- LaTeX-inspired typography, with instant build up from linear to ‘professional’ rendering;
- in-built annotation tools such as textboxes, callouts, arrows, etc.;

The dual input approach potentially provides a flexible way for tutors to mark student work, whether it be a typeset document or images of scanned handwritten work.

**Marking of maths eTMAs**

Tutors participating in the trial were free to mark submitted eTMAs using any of the methods made available to them through Word 2007 including but not limited to:

- use of review and comment facilities;
- typed annotation inserted within, or at the end of, the student’s document;
- typed annotation contained within textboxes and placed over the student’s work;
- digital inking either through a tablet PC or via a plug-in graphics tablet.

Some of these approaches are more suited to certain types of processed work than others. As a result of the processing described above, tutors receive one of two types of Word 2007 file: those essentially consisting of embedded images of students’ work; and those containing editable text. For files of the latter type, any of the above approaches can be adopted. However, for those consisting of embedded images, the first two approaches are not generally appropriate. The review and comment facilities of Word 2007 do not enable specific parts of an image to be commented upon, but simply relate comments to the image as a whole. Similarly, typed comments cannot be inserted at an appropriate point in an image – they must be placed on a new inserted page. The comments are then not closely related to the specific point or error in the student’s work to which they refer. In such cases, the latter two styles of marking are more appropriate, although the need to open a textbox before inserting typed comments was found to be time consuming.

The native digital inking facilities of Word 2007 are only available when using the Microsoft Windows XP Tablet Edition or Vista operating systems. Tutors without these facilities were invited to purchase third party inking software. During the trial some tutors adopted other approaches to marking, on at least some of their TMAs, such as PDF annotation or use of a ‘Pegasus Note Taker’.

**MOL marking tools**

The results of the small pilot trial of electronic marking of maths eTMAs conducted in summer 2007 indicated that marking work electronically is, at least initially, more time consuming than the traditional paper-based activity. This observation was supported more widely by the results of an
internal OU survey in December 2007 of associate lecturers engaged in the electronic marking of student work across the University.

Consequently, the following priorities were identified for an additional marking tool ribbon within Word 2007 to be developed by the Maths Online team.

- Facility to set defaults for
  - callouts
  - textboxes (format and font)
  - colour and width of pen
- Insert ticks
- Textboxes and callouts
- Circling text
- Insert or paste a textbox exactly where it is required
- Callouts with more than one arrow
- Textboxes and callouts which expand as they are filled
- Mathematical notation:
  - Quick facility to underline vectors
  - Quick facility to add an overbar
  - Non-breaking spaces
  - Changing maths fonts
- Facility to rotate individual pages (graphs are often scanned into a document sideways)
- Facility to annotate students’ graphs
- Facility to keep a running total of marks
- Facility to insert comments within the student’s solution

The first generation of MOL-developed marking tools, with documentation, were made available for tutors to download from a MOL-hosted website in early March 2008. As part of the installation process, it was necessary for tutors to download and install ‘Microsoft Visual Studio 2005 Tools for Office Second Edition runtime’ and ‘2007 Office System: Microsoft SDK for Open XML Formats’. Depending on the current state of the tutor’s operating system, it was also necessary for some to install ‘.NET framework 3.0’.

The tools then appeared as icons in an additional ribbon within Word 2007, with functionality as described in the table below.

<table>
<thead>
<tr>
<th>Tools</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Document manipulation tools</strong></td>
<td>Should it be required, a document consisting of embedded images could be unlocked, allowing rotation and re-ordering of embedded images.</td>
</tr>
<tr>
<td><strong>Insertion tools</strong></td>
<td>Insertion of ticks or other symbols at given points in the document. These are automatically contained within textboxes to enable them to be overlaid on embedded images.</td>
</tr>
</tbody>
</table>
A second generation of tools was developed in response to the feedback received on these tools. Working within Word 2007 proved to be more difficult than anticipated and the second set of tools were only released to four volunteers in September 2008. They addressed the main problems in positioning textboxes and in the instability of the marks insertion tool.

The second set of tools also contained a palette of ticks, crosses, images and shapes, which could be inserted by double clicking on the Word document at the required point of insertion. The colour and style of the images and shapes could be changed. Keyboard shortcuts for some of the tools were provided to allow faster switching between the marking ribbon and other Word 2007 ribbons.

**Evaluation methodology**

The evaluation of the trial is split between two COLMSCT projects.

The first COLMSCT project (GA) had the following aims:

1. To investigate logistic, technical and pedagogical aspects of electronic marking (eMarking) of Tutor Marked Assignments (eTMAs) for mathematics courses. The investigation will include (i) the effect of eMarking on the quality of the marking and of the feedback to students; and (ii) the effect of electronic submission by students on the quality of their TMAs, in particular, on the balance between form and content, and development of good mathematical style.

2. To analyse the functionality of a range of software and hardware approaches to the marking of eTMAs, primarily including Word 2007 and annotation through use of Tablet Pens and/or the inking facility within Word 2007.

3. To synthesise the results from the above study to formulate a practical and pedagogically sound mechanism for the introduction of eTMAs within mathematics courses.

The second COLMSCT project (SC) had the following aims:

1. To draw on Associate Lecturers’ experience of the Word 2007 mini-trial and other COLMSCT projects this area to identify key technological and pedagogical issues to inform the development of marking tools and subsequent development of marking tools.

2. To design and collate a prioritised list of marking tools for development in autumn 2007 in preparation for the 08B extensive trial.

3. To assist with the 08B eTMA trial and, specifically, to design and implement the evaluation of the marking tools as part of the 08B trial.

4. To report the findings of the evaluation and to make recommendations on the use of marking tools in mathematics eTMAs.

5. Additionally, to investigate how electronic marking affects the quality and quantity of feedback and overall style of marking compared with paper TMAs.

A number of sources of data were used to inform both projects:

- three tutor surveys;
- short and relatively informal regular reports from tutors;
• comments and queries from tutors posted to the online conference, or emailed directly;
• comments and queries from students posted to the online conference, or emailed directly;
• data from the OU’s main eTMA system;
• data from the maths eTMA processor;
• one survey of students in the trial tutor groups;
• scrutiny of marked eTMAs as delivered by tutors to the OU’s main eTMA system, and of the corresponding paper TMAs.

The four surveys were conducted through the OU’s Survey Office and were drawn up by identifying key areas of interest in consultation with stakeholders. The tutor surveys focused on ease of use of the available tools, convenience of e-marking, reliability of Word 2007 and quality of feedback to the student. The questionnaires included a mixture of Likert-scale questions and prompts for free-form responses, as appropriate for such a small scale trial (Cohen, Manion, & Morrison, 2003). This approach was adopted to best capture the perceptions of participants, whilst allowing unanticipated issues to be raised (Dermo, 2009). Care was taken to avoid possible ambiguities, leading questions and bias in the survey (Verma & Mallick, 1999).

**Tutor surveys**

All the tutors on the trial (excluding SC) were asked to complete three formal surveys. It was decided to run three surveys in order to try to capture if and how tutors’ experiences and views changed as they became more accustomed to marking maths eTMAs. For this reason many of the questions were common to all three surveys. Each survey also had a number of questions which were asked only on that survey, as follows.

<table>
<thead>
<tr>
<th>Survey</th>
<th>Timing</th>
<th>Questions specific to this survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>May, to capture initial reactions at the beginning of their learning curve</td>
<td>Views on training and documentation provided. Use of TMA00.</td>
</tr>
<tr>
<td>2</td>
<td>August, to capture views as tutors settle into a way of working</td>
<td>Technical issues with file sizes and types, Word 2007, inking etc.</td>
</tr>
<tr>
<td>3</td>
<td>October, to capture views as they become experienced with maths eTMAs</td>
<td>Diagrams Overall final views on maths eTMAs</td>
</tr>
</tbody>
</table>

In soliciting feedback from tutors, the surveys attempted to separate responses on e-marking from those on the use of the eTMA system. However some factors, such as scrolling and screen reading cannot be easily abstracted. (Cook, 2005), following (Friedman, 1994), argues that comparison of the media involved in learning (e.g. computer compared to paper) is logically impossible because there are no valid comparison groups. He argues that comparison of different computer-based learning models is more rigorous because the variables can be better controlled. He cites the multiplicity of variables in comparisons of different media, including using computer systems, reading from a computer screen and scrolling through documents, as a barrier to valid comparison. In designing the surveys, the limitations of such comparisons were taken into account, particularly when assessing time taken to mark.

**Regular reports**

From April onwards tutors were asked to send a short report to the online conference, after marking each batch of maths eTMAs, to cover in particular:

• Average marking time per eTMA (not including use of eTMA system).
• Most significant technical issue (e.g. eTMA system, Word 2007, different file formats, document manipulation, use of marking tools ...).
• Which facilities they made use of (e.g. inking, maths typesetting in Word 2007, MOL marking tools). Why? Has this changed?
• What they might do differently next time.
By the end of the trial a total of 42 regular reports had been received from fifteen of the tutors.

**Student survey**

All the students in the participating tutor groups at the end of August were invited to complete a formal survey⁴. The invitation was issued around the time they were working on their final TMA, and the survey closing date fell before the main exam revision period.

Students who had not submitted any eTMAs were simply asked to give their reasons for not doing so, and to indicate if they would on future maths courses. Students who did submit one or more maths eTMAs were asked about their experiences of preparing and submitting their work, and on their reactions when they received their marked work. Those who used Word 2007 to prepare eTMAs were given the option of commenting on their experiences of using it.

**Stages**

The evaluation of the trial has been categorised into three stages, broadly relating to the three tutor surveys. However it should be noted that these divisions are not rigid in time. A few of the tutors, especially those experienced in using the OU’s main eTMA system, very quickly found a way of marking maths eTMAs which worked for them. These tutors moved further along the learning curve of working with maths eTMAs more quickly than the majority, and this was taken into account in terms of interpreting their responses and comments. Conversely, a small number of tutors only had the opportunity to work on a very few maths eTMAs, and never really got beyond the novice phase.

**Outputs**

As well as this report, it should be possible to use the outcomes of the trial to inform:

- future development of the OU’s main eTMA system;
- policy and the practicalities of rolling out eTMAs across mathematics and statistics courses;
- advice and guidance to tutors (and students) before and as they work with maths eTMAs.

**Submission data**

**Number of maths eTMAs submitted**

By the end of the trial, 207 students had submitted one or more maths eTMAs (from a population of 665 students (i.e. student courses) in the 41 participating tutor groups at the end of July⁵). A total of 703 valid maths eTMAs had been successfully submitted, processed and forwarded to the University’s main eTMA system for collection by tutors. The submission numbers for each eTMA, by 1st October, are as follows.

<table>
<thead>
<tr>
<th>TMA</th>
<th>00 (Test)</th>
<th>01</th>
<th>02</th>
<th>03</th>
<th>04</th>
<th>05</th>
<th>06</th>
<th>07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number submitted</td>
<td>107</td>
<td>101</td>
<td>143</td>
<td>136</td>
<td>131</td>
<td>30</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>Percentage of 665</td>
<td>16.1</td>
<td>15.2</td>
<td>21.5</td>
<td>20.5</td>
<td>19.7</td>
<td>4.5</td>
<td>4.1</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Notes:

Not all students who later submitted an eTMA chose to submit a test TMA00, although they were encouraged to do so. TMA01 for MU120, MST121, M208, MST209, M249 and MS325 was excluded from the trial because it is a split TMA.

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⁴ Students were excluded if they had previously informed the University that they didn’t wish to participate in any institutional surveys, or if they had already been invited to participate in the maximum number of surveys permitted for each student in a year.

⁵ Obviously, this is considerably fewer students than there would have been registered earlier in the course presentation. For example, at the beginning of June there were 713 student courses across the 41 tutor groups. However, the August numbers for each tutor group are used as the base number for submission data in this report, as there is unlikely to be further significant student withdrawals from courses.
The following graph shows the number of eTMAs submitted by individual students, with TMA00s included in the count, and noting that only two of the courses permitted 6 summative eTMAs to be submitted, seven courses permitted 4, two courses permitted 3, and one course only permitted 2. The graph suggests that over half the students submitted all, or all but one, of their TMAs electronically, but that about a quarter submitted only one eTMA (which may have been TMA00).

**Number of eTMAs submitted by individual students (as at 1 October 2008)**

Of the 84 students who had submitted one or more eTMAs and who responded to the student survey, the following graph shows which TMAs they submitted electronically.

**Percentage of students (who responded to the student survey) submitting each TMA**

The following three graphs show, respectively:

- the total number of each TMA submitted, by course;
- the average number per tutor group of each TMA submitted, by course;
- the average percentage of students per tutor group submitting each TMA, by course.
Number of maths eTMAs by course (at 1 October 2008)

Average number of maths eTMAs per course tutor group (at 1 October 2008)
Average percentage of students per tutor group submitting each TMA (at 1 October 2008, but based on number of students per group at 1 August)
The graphs suggest some general trends. Electronic submission was most popular on statistics courses, such as M248 where much of the TMA work is done on computer. There was little difference between e-submission rates on pure and applied courses. Putting the statistics courses aside, eTMAs were slightly more likely to be submitted on higher level courses, than lower level. However, eTMAs were also popular on Level 1 courses, possibly because these attract a greater proportion of students who have done previous OU courses where e-submission may be encouraged or compulsory. The lower level courses, especially MU120, and the statistics courses, also require relatively less mathematical notation in students’ work. To some extent, submission rates may have been affected by the way eTMAs were ‘promoted’ to students by their tutor.

**Types of maths eTMAs submitted**

About 72% of the 703 eTMAs submitted by 1 October consisted of a single file, with the rest containing multiple files. Multiple files could be a mixture of two or more document types, such as: word-processed, PDF, images, application files (e.g. Mathcad, Maple), etc. The following table indicates the range of document types.

<table>
<thead>
<tr>
<th>Document type</th>
<th>doc</th>
<th>pdf</th>
<th>docx</th>
<th>jpg</th>
<th>bmp</th>
<th>mcd</th>
<th>mws</th>
<th>sxw</th>
<th>mpj</th>
<th>gif</th>
<th>ds_store</th>
<th>jpeg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>241</td>
<td>238</td>
<td>126</td>
<td>112</td>
<td>4</td>
<td>42</td>
<td>26</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Document type</td>
<td>zip</td>
<td>db</td>
<td>mtw</td>
<td>rtf</td>
<td>rtf</td>
<td>xsx</td>
<td>tiff</td>
<td>tif</td>
<td>txt</td>
<td>xls</td>
<td>rar</td>
<td>odt</td>
</tr>
<tr>
<td>Number</td>
<td>1</td>
<td>9</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

The main file types for the 703 submissions are shown in the pie-chart (these include submissions where a ‘subsidiary’ type of file, such as Mathcad or Maple, accompanied one of the four main types). Here all image documents are classed as one type, and ‘mixed’ indicates submissions containing two (or possibly more) of these four main file types or submissions containing none of these four main file types (of which there were one or two).

Of the 703 eTMAs submitted only fifteen included the optional request for colour to be preserved in the processing, to indicate that the student had used colour in a significant way in the TMA. Generally tutors didn’t report lack of colour as being an issue.
Processing of maths eTMAs

Time to process
The mean time to process a submission (from time of arrival of the student’s email to forwarding of the student’s work to the main eTMA system) was 99.2 seconds (with standard deviation 91.0), and the median time was 65.0 seconds (noting that the processor only looked for a new submission every minute). The maximum time taken by any one submission was 704.0 seconds (nearly 12 minutes), but this could be due to queuing rather than actual processing time.

File sizes
Data on the sizes of files received and processed is as follows. The size of the forwarded email attachment indicates the size of files which tutors have to download. Annotation by the tutor, whether in Word 2007 or by inking, can further increase the file size quite considerably.

<table>
<thead>
<tr>
<th>Size in Mb of email attachment</th>
<th>sent by student</th>
<th>forwarded to main eTMA system *</th>
<th>forwarded to main eTMA system (Word 2007 only)</th>
<th>Unmarked received by main eTMA system (AACS data) *</th>
<th>Marked returned to eTMA system and student (AACS data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.915</td>
<td>0.745</td>
<td>0.641</td>
<td>0.792</td>
<td>1.245</td>
</tr>
<tr>
<td>Median</td>
<td>0.335</td>
<td>0.543</td>
<td>0.398</td>
<td>0.646</td>
<td>1.034</td>
</tr>
<tr>
<td>Maximum</td>
<td>15.988</td>
<td>2.954</td>
<td>2.954</td>
<td>2.919</td>
<td>5.173</td>
</tr>
<tr>
<td>s.d.</td>
<td>1.529</td>
<td>0.713</td>
<td>0.661</td>
<td>0.711</td>
<td>1.017</td>
</tr>
</tbody>
</table>

* The small discrepancies between the maths eTMA processor data and the main eTMA system data are due to a number of identified factors, none of which is considered to be of significance.

Errors in processing
Of the 207 students who submitted maths eTMAs, forty-nine made at least one multiple attempt at submitting a TMA.

There was a total of nineteen rejected submissions (i.e. ones that would have been rejected by the University) to the maths eTMA processor, of which about half had an invalid student number, and half had an invalid course code (usually one character different / omitted / added).

Of the 703 valid eTMAs submitted, seven generated a failed processing email to the student, caused by, for example, an inappropriate file extension.

The maths eTMA system performed remarkably well during the trial, and required little intervention from the Maths Online team members. Any problems which did arise were usually associated with an individual student’s submission. There was only one occasion when the system failed overnight, and it couldn’t be rectified on the next working day (because of leave). In that instance, the five affected students (and their respective tutors) were informed of the delay in processing their work, and four assignments were actually delivered after the cut-off date as a result.

The tutors’ perspective

Number of maths eTMAs marked
By the end of the trial the number of maths eTMAs received by individual tutors ranged from 7 to 91, with a mean of 29 per tutor (median 22). The 91 were received by a tutor with two tutor groups on the same statistics course. The next largest number received, 88, went to a tutor with six tutor groups in the trial. The 7 were received by one of the co-authors of this report, who had a small MU120 group, for which only two summative TMAs were permitted to be submitted electronically. The next lowest number received by an individual tutor was 11.
Marking times

Average times

In their regular reports tutors were asked to give an indication of the average marking time, in hours, per eTMA, excluding use of the OU’s main eTMA system. They were also asked to try to exclude initial setting up and learning time for using Word 2007, marking tools etc; and to exclude time taken for setting up repositories of comments etc.

<table>
<thead>
<tr>
<th>Report submitted in</th>
<th>Tutor</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Mean per tutor</th>
<th>Number of eTMAs at 1/10/08</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>2</td>
<td>2</td>
<td>2.25</td>
<td></td>
<td></td>
<td></td>
<td>2.08</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>2.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.50</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.00</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>2</td>
<td>1.25</td>
<td>1.5</td>
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<td>1.5</td>
<td>1.55</td>
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<td>2.75</td>
<td>2.75</td>
<td>2.3</td>
<td>2.86</td>
<td>2.86</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>1.5</td>
<td>1</td>
<td>1.25</td>
<td>1</td>
<td>1</td>
<td>1.15</td>
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<td>1.75</td>
<td>1.75</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>2</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td></td>
<td>3.75</td>
<td>3.75</td>
<td>22</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td>3.00</td>
<td>3.00</td>
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<td>3.00</td>
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<tr>
<td></td>
<td>S</td>
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<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
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<tr>
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<td>T</td>
<td>1.7</td>
<td>1.25</td>
<td></td>
<td></td>
<td></td>
<td>1.48</td>
<td>1.48</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>U</td>
<td>1.5</td>
<td>3.5</td>
<td></td>
<td></td>
<td></td>
<td>2.50</td>
<td>2.50</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>X</td>
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<td>1.75</td>
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<td>1.25</td>
<td>1.58</td>
<td>1.72</td>
<td>62</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>1.91</td>
<td>1.71</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.71</td>
<td>1.72</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.58</td>
<td>1.58</td>
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<td></td>
<td></td>
<td>2.56</td>
<td>1.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>hours</td>
<td>699</td>
</tr>
</tbody>
</table>

Notes

1. The reference letter for each tutor is that given in the table of marking facilities used by tutors in the ‘Use and rating of tools’ section below.
2. The group of tutors who provided this data doesn’t include any of the three tutors who exclusively or mainly used inking.
3. Where a range of times was given (usually when only a small number of eTMAs had been received), the median has been recorded.
4. Where different times for different courses have been given by an individual tutor the mean has been recorded.
5. Where, for example, a time of 2+ hours was given, 2 hours has been recorded.
6. The time of 6 hours reported by one tutor arose as a result of marking two very poor scripts (in a batch of four), each taking 8 – 10 hours. ‘I inserted many (perhaps too many!) teaching comments on these poor scripts; although to some extent I was able to ‘copy and paste’ from a ‘TMA02 comments’ file, this was still time-consuming – partly because I am very conscientious about checking references to sections of the course material and other details. ... The format used [Word 2007] for one of the poor scripts was also a factor ...’

A number of factors should be borne in mind when considering the reported marking times.

- Most tutors marked their paper TMAs first, and hence were already familiar with the mark scheme and common errors before marking eTMAs.
- The only tutor who reported marking of eTMAs taking less time than marking of paper TMAs is on a statistics course. ‘In M248 there is little need to do more than insert textual comments and I find I can do this perfectly well in Word.’
- Some early TMAs in a course tend to be less demanding for students, and possibly likewise for tutors.
Some tutors who reported very high times also stated that the corresponding paper TMAs had also been time consuming to mark.

Some tutors suggested that it was the more able students who chose to submit eTMAs, and express concerns over marking times if they were to receive more eTMAs from weaker students. ‘Good scripts take not much more time at all, if any. But the weak ones take much more, as interacting with the students' answers is very time consuming.’ ‘All but one of the scripts that I have marked so far have been of a very high standard and well presented. Marking a confused script could be a very long exercise.’

One or two tutors remarked that the usual time efficiency for good scripts was lost: ‘It took me about the same time to mark poor scripts as good ones which is not my usual experience.’

Particularly in June and July, some tutors recorded relatively low times, but stated that this was because the students’ work was excellent and needed few corrections or comments.

Perhaps out of necessity, those receiving large numbers of eTMAs tended to have lower marking times per TMA.

Even tutors who had some previous experience of marking maths eTMAs (on the previous maths e-marking mini-trial) reported long marking times: ‘I was surprised how long it took, probably double the time even for an assignment worth 100%.’

In the surveys the tutors consistently said that markings times were between ‘significantly more’ and ‘slightly more’ than times for marking corresponding paper TMAs, with a very small number reporting a small improvement towards the end. Only three tutors at one point or another said that eTMAs didn’t take any longer than paper TMAs. ‘We do not have the tools for the job, yet. I find that it takes at least twice as long to mark an assignment electronically.’ ‘I am not optimistic that I will ever be able to reduce eTMA marking times to be comparable with that for paper based TMAs.’

There is some evidence that those who used exclusively typesetting or inking were slightly less likely to report that their markings times were ‘significantly more’ compared to times for marking paper TMAs, than those adopting a more mixed approach.

Most tutors were, however, aware of factors which might improve their marking efficiency, as follows [in order of frequency of mention across the trial]:

1. Build up a bank of comments, solutions, diagrams etc appropriate to each TMA questions which, to some extent, they can re-use. ‘I believe that when many eTMAs are being done, there will be more cost savings, as students do tend to repeat mistakes, so for example the same equations can be re-used many times. Also, gradually over a series of presentations, previously written equations, comments or material might be re-usable, or changed with little effort. With just a few eTMAs being received, each one takes a lot of effort at present.’ [Often combined with ...]

2. Have a critical mass of eTMAs for any one assignment to mark. ‘I feel that my time would reduce if I had a number of eTMAs for the same assignment. However, there is such a low take-up I don't get much opportunity to reuse my efforts.’ ‘I expect my mean marking time per eTMA would reduce if all students were required to submit electronically, as this would give more scope, after an initial investment of time and effort, for re-using frequently-needed comments and solutions.’ ‘I have begun to save equations to re-use in other TMAs. This becomes useful when there are several TMAs to mark. With only four, it was hardly worth saving anything to re-use.’

3. Tutor notes [i.e. marking schemes and guidance] and solutions provided in an appropriate format by Course Teams. ‘Marking eTMAs would be easier than paper ones if the tutor notes were available online to use for giving the students part or full worked answers (especially for weaker students).’
4. Become more practised with handling eTMAs and more familiar with their preferred approach to marking maths eTMAs. ‘I am sure that the more I mark, the quicker it will become, as I settle into my own preferred methods.’

5. If Word 2007 is to be used, the marking tools (developed by MOL) must become more stable, effective and easier to use.

Main factors which affect marking times

In the first survey, tutors were asked about factors which increase marking times for eTMAs. Similar comments were made in later surveys, regular reports and in messages to the conference.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number of times cited in survey 1</th>
<th>Number of times cited in survey 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioning textboxes</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Scrolling (specifically for adding marks)</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Typing slower than writing (specifically maths)</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Inking, including switching between pen and keyboard</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Inserting ticks (tutors want this to be as fast as on paper)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Downloading / uploading, making copies (including PDFs)</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Working with embedded images</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Getting used to the various tools</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Interacting with the script (highlighting, ringing, underlining)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Going back and forth between the script and the PT3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Word 2007 running slow or crashing</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Factors which help to reduce marking times of eTMAs.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number of times cited in survey 1</th>
<th>Number of times cited in survey 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-use of (longer) comments / solutions</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>‘Nothing’</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Practice – developing one’s own efficient system</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Familiarisation with the mark scheme (by marking paper TMAs first)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Convenience of e-PT3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Being able to look back quickly at other scripts</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Inking rather than typing</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Editable Word documents rather than embedded images</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

When asked explicitly, 75% also found ease of rectifying own errors at least moderately helpful. However, this may be perceived not so much as a time issue, but simply as an advantage to be able to correct mistakes neatly. ‘Comments can be changed/modified after insertion, which is a good feature (when I have written in biro on a TMA script, it is hard (or embarrassing) to change it).’

Overall the trial didn’t produce conclusive evidence of potential for faster return of TMAs to students because most tutors received relatively few eTMAs and tended to mark them after the corresponding paper TMAs. Comments suggested that return times were subject to the same pressures and variations as turnaround for paper TMAs - tutors have different approaches - some waiting for the whole group to submit, some marking as TMAs arrive. Several of the trial tutors

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6 The PT3 form contains the tutor’s summary comments and marks, and is returned with the annotated work.
reported that, as they mark the paper copies first, turnaround time for eTMAs will not necessarily be faster. Some appreciated that students get the work back faster once the marking has been done. ‘Pleased how quickly the eTMAs are returned to students and the student record updated.’ ‘The lack of dependence on Royal Mail is a massive advantage of electronic marking.’

Convenience and related issues
Tutors were asked about the convenience, in terms of how and when marking is carried out, compared to paper TMAs. In the first survey, in terms of handling TMAs, about half thought it less convenient and a quarter more convenient. However, in terms of actually marking, about 50% found eTMAs less convenient and 60% found them less flexible than paper TMAs, whereas only 17% thought eTMA marking more flexible and convenient.

Initially, 17 tutors found marking eTMAs more stressful (7 significantly more) than paper TMAs, the rest found it about the same. There is some evidence that those tutors using either inking or typesetting exclusively were inclined to give slightly better ratings for these factors.

As can be seen from the following table, the ratings for convenience of handling eTMAs and for stress, in particular, tended to deteriorate as the trial progressed.

<table>
<thead>
<tr>
<th>1 = Significantly less</th>
<th>2 = Slightly less</th>
<th>3 = About the same</th>
<th>4 = Slightly more</th>
<th>5 = Significantly more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall to what extent is handling maths eTMAs more or less convenient than handling paper TMAs in terms of where and when marking is carried out</td>
<td>2.74</td>
<td>2.57</td>
<td>2.18</td>
<td>2.50</td>
</tr>
<tr>
<td>Overall to what extent is marking maths eTMAs more or less convenient than marking paper TMAs in terms of how you mark</td>
<td>2.52</td>
<td>2.22</td>
<td>2.32</td>
<td>2.35</td>
</tr>
<tr>
<td>Overall to what extent is marking maths eTMAs more or less stressful than marking paper TMAs</td>
<td>4.04</td>
<td>4.09</td>
<td>3.86</td>
<td>4.00</td>
</tr>
<tr>
<td>Overall to what extent is marking maths eTMAs (more or less flexible than marking paper TMAs in terms of where and when marking is carried out</td>
<td>2.48</td>
<td>2.3</td>
<td>2.45</td>
<td>2.41</td>
</tr>
</tbody>
</table>

Several tutors commented that working on eTMAs is restricting and / or a health and safety issue.

- ‘I dislike spending too long at a time looking at a computer screen.’
- ‘I find I have to tell myself to take a break – the time at the computer usually turns out to be longer that the time recommended by the H & S E if I try to complete the marking of one TMA at one sitting.’
- ‘There is a H&S aspect. When I first used a laptop to mark an eTMA I found I got immediate back pains. This was from being hunched over the keyboard as I type. It’s very difficult to spend a lot of time at a laptop without causing strain. (Conversely using a desktop immediately takes away all the advantages about where and when I can mark.)’
- ‘To sit in front of my computer is very restricting as to times / circumstances of marking.’
- ‘I need to be at home with my PC to do everything now - I cannot mark scripts, write PT3s etc and return scripts without being at home. I don’t have a laptop to facilitate this, if I did then my flexibility would be greatly improved. e.g. I could take work on the train mark, etc.’
- ‘I still find this method of marking time consuming and can’t pick it up and drop it so easily as I need to boot up the computer before I can start marking. I tend to leave it until I have a good stretch of time to mark rather than using the odd half hour which I sometimes do with the paper marking.’
- ‘I share my PC, and the room it’s in, with the rest of the family; and I find e-marking significantly more tiring (to the eyes, and to the brain!) than marking on paper.’
- ‘It’s less convenient for) ‘comparing answers to same question on several scripts.’
A number of tutors commented that they would need a laptop if marking larger numbers of eTMAs, to give them greater flexibility and convenience. A large screen was also thought advantageous.

- ‘I’m quite enjoying it, but it is SO time consuming. I keep having to remind myself that it’s not the student’s fault s/he has sent me an eTMA, as I get so annoyed at how long it takes just to tick something. I wish I had a tablet PC. Or was on the science trial since I gather they’re given one there.’
- ‘To significantly improve flexibility I’d need a laptop, which I don’t have and see no (other) need to purchase.’
- ‘It has been quite stressful at times. If numbers increase dramatically I will probably get a note-book type of laptop so the marking process is as close to paper marking as possible.’
- ‘I now write the comments on PT3 while adding up the marks having two windows open.’

Use and overall rating of tools

By reviewing marked TMAs and tutors’ responses to survey question, it has been possible to build up a picture of the extent to each tutor used the different marking facilities, as summarised in the following tables.

<table>
<thead>
<tr>
<th>Approach</th>
<th>Number of tutors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exclusively typesetting</td>
<td>10</td>
</tr>
<tr>
<td>Mostly typesetting</td>
<td>3</td>
</tr>
<tr>
<td>Mix of typesetting and inking</td>
<td>8</td>
</tr>
<tr>
<td>Mostly inking</td>
<td>1</td>
</tr>
<tr>
<td>Exclusively inking</td>
<td>2 (both had a Tablet PC)</td>
</tr>
</tbody>
</table>

Of the 21 tutors who used typesetting, use of specific facilities within Word 2007 was as follows.

<table>
<thead>
<tr>
<th></th>
<th>Direct typing</th>
<th>Maths</th>
<th>Track Changes</th>
<th>Insert Comment</th>
<th>Textbox / Callout</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>all eTMAs</td>
<td>on editable eTMAs only</td>
<td>all eTMAs</td>
<td>on image eTMAs only</td>
<td></td>
</tr>
<tr>
<td>always</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>mostly</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>mixed</td>
<td>4</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>occasionally</td>
<td>3</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>never</td>
<td>8</td>
<td>0</td>
<td>7</td>
<td>18</td>
<td>19</td>
</tr>
</tbody>
</table>

The approach adopted by each individual tutor is detailed below. The use of Inking and Typesetting are rated on the scale: 5 exclusively; 4 mostly; 3 partially; 2 occasionally; 1 never or no evidence. For those tutors who used Typesetting, their use of the facilities within Word 2007 (direct typing, maths, track changes, insert comment, textbox / callout) are rated on the scale: 5 always; 4 mostly; 3 mixed; 2 occasionally; 1 never. The (E) indicates that this approach was only adopted on editable Word documents, and the (I) that the approach was only adopted on documents consisting of images.

In the second survey tutors were asked if they had found it easier to work on documents which consisted of embedded images, or those which were editable within Word 2007. Those mainly or exclusively typesetting tended to prefer editable documents, although the split was not clear cut.
<table>
<thead>
<tr>
<th>Tutor</th>
<th>Inking</th>
<th>Typesetting in Word 2007</th>
<th>W07 direct typing</th>
<th>W07 maths</th>
<th>W07 Track changes</th>
<th>W07 insert comment</th>
<th>W07 textbox / callout</th>
<th>Tutor's preference</th>
<th>Summary of facilities used by each tutor</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>Images</td>
<td>Mix textbox / callout, maths &amp; inking (NoteTaker).</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
<td>Mix textbox / callout, Word maths &amp; inking.</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
<td>Mix textbox / callout &amp; inking</td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>Editable</td>
<td>Word, possibly dabbled with inking at start</td>
</tr>
<tr>
<td>E</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>3 (I)</td>
<td>Editable</td>
<td>Mix textbox / callout, Word maths &amp; inking.</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>Editable</td>
<td>Mix textbox / callout, Word maths &amp; inking.</td>
</tr>
<tr>
<td>G</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>Editable</td>
<td>Word textbox / callout and maths, possibly dabbled with inking</td>
</tr>
<tr>
<td>H</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>Editable</td>
<td>Word textbox / callout and maths, possibly dabbled with inking</td>
</tr>
<tr>
<td>I</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
<td>Word textbox / callout and maths, possibly dabbled with inking</td>
</tr>
<tr>
<td>J</td>
<td>1</td>
<td>5</td>
<td>5 (E)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4 (I)</td>
<td>Editable</td>
<td>Word textbox / callout</td>
</tr>
<tr>
<td>K</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>Editable</td>
<td>Mix textbox / callout, Word maths &amp; inking.</td>
</tr>
<tr>
<td>L</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>Editable</td>
<td>Mix textbox / callout &amp; inking. Possibly dabbled with Word maths</td>
</tr>
<tr>
<td>M</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>Editable</td>
<td>Word</td>
</tr>
<tr>
<td>N</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>Editable</td>
<td>Mix textbox / callout &amp; inking. Possibly dabbled with Word maths</td>
</tr>
<tr>
<td>O</td>
<td>2</td>
<td>4</td>
<td>4 (E)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4 (I)</td>
<td>Editable</td>
<td>Mix textbox / callout &amp; inking. Possibly dabbled with Word maths</td>
</tr>
<tr>
<td>P</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Images</td>
<td>Exclusively inking</td>
</tr>
<tr>
<td>Q</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td>Word textbox / callout and maths</td>
</tr>
<tr>
<td>R</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>Editable</td>
<td>Mix textbox / callout &amp; inking. Tried Word maths at start.</td>
</tr>
<tr>
<td>S</td>
<td>1</td>
<td>5</td>
<td>5 (E)</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5 (I)</td>
<td>Editable</td>
<td>Word textbox / callout and maths, possibly dabbled with inking</td>
</tr>
<tr>
<td>T</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4 (I)</td>
<td>Images</td>
<td>Word (although didn’t like it!!)</td>
</tr>
<tr>
<td>U</td>
<td>1</td>
<td>5</td>
<td>4 (E)</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4 (I)</td>
<td></td>
<td>Mix textbox / callout, Word maths &amp; inking.</td>
</tr>
<tr>
<td>V</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>Exclusively inking</td>
</tr>
<tr>
<td>W</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>Editable</td>
<td>Word textbox / callout, possibly dabbled with inking at start</td>
</tr>
<tr>
<td>X</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>Editable</td>
<td>Word textbox / callout and maths, possibly dabbled with inking</td>
</tr>
</tbody>
</table>
Throughout the trial tutors were asked how helpful they found each of the available tools in enabling them to provide effective ‘correspondence’ tuition, on a scale 1 (Not at all helpful) to 5 (Very helpful). Overall the Word 2007 in-built editing facilities and MOL-developed tool were rated more highly for editable documents, and inking was rated more highly for embedded images. Ratings tended to increase towards the end of the trial but preferences became more polarised between those who had reliable inking facilities and those who did not.

<table>
<thead>
<tr>
<th>Maths eTMAs (embedded images)</th>
<th>Overall ranking</th>
<th>May</th>
<th>July</th>
<th>October</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOL marking tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Document manipulation tools</td>
<td>5</td>
<td>3.43</td>
<td>3</td>
<td>3.14</td>
<td>3.19</td>
</tr>
<tr>
<td>(b) Insertion / repository tools</td>
<td>3.42</td>
<td>3</td>
<td>3.5</td>
<td>3.31</td>
<td></td>
</tr>
<tr>
<td>(c) Marks insertion tools</td>
<td>2.67</td>
<td>2.83</td>
<td>3.33</td>
<td>2.94</td>
<td></td>
</tr>
<tr>
<td>Textboxes / Callouts</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(not using the MOL marking tools ribbon)</td>
<td>4.45</td>
<td>4.35</td>
<td>4.42</td>
<td>4.41</td>
<td></td>
</tr>
<tr>
<td>Track changes (within Word 2007)</td>
<td>3</td>
<td>4.4</td>
<td>3.4</td>
<td>4</td>
<td>3.93</td>
</tr>
<tr>
<td>Comments (in Word 2007 Review ribbon)</td>
<td>4</td>
<td>3.71</td>
<td>3.4</td>
<td>4.2</td>
<td>3.77</td>
</tr>
<tr>
<td>Ink annotations</td>
<td>2</td>
<td>3.71</td>
<td>4</td>
<td>4.17</td>
<td>3.96</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maths eTMAs (editable Word)</th>
<th>Overall ranking</th>
<th>May</th>
<th>July</th>
<th>October</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOL marking tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Document manipulation tools</td>
<td>5</td>
<td>3.75</td>
<td>2.8</td>
<td>3.2</td>
<td>3.25</td>
</tr>
<tr>
<td>(b) Insertion / repository tools</td>
<td>3.33</td>
<td>3.25</td>
<td>3.88</td>
<td>3.49</td>
<td></td>
</tr>
<tr>
<td>(c) Marks insertion tools</td>
<td>2.89</td>
<td>3.14</td>
<td>4</td>
<td>3.34</td>
<td></td>
</tr>
<tr>
<td>Textboxes / Callouts</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(not using the MOL marking tools ribbon)</td>
<td>4.15</td>
<td>3.94</td>
<td>4.29</td>
<td>4.13</td>
<td></td>
</tr>
<tr>
<td>Track changes (within Word 2007)</td>
<td>1</td>
<td>4.75</td>
<td>4</td>
<td>4.25</td>
<td>4.33</td>
</tr>
<tr>
<td>Comments (in Word 2007 Review ribbon)</td>
<td>4</td>
<td>3.83</td>
<td>3.4</td>
<td>4</td>
<td>3.74</td>
</tr>
<tr>
<td>Ink annotations</td>
<td>3</td>
<td>3.63</td>
<td>3.71</td>
<td>4.23</td>
<td>3.86</td>
</tr>
</tbody>
</table>

Although there were problems with the MOL-developed tools, some tutors did like aspects of them and persevered with their use.

In the third survey tutors were asked about the method they used to create diagrams for their annotations, with multiple responses permitted.

| Diagrams not required         | 36%             |
| Taken images from PDFs of tutor notes, course units, etc | 36%             |
| **Within another application and imported**             | **32%**         |
| Hand-drawn and scanned       | 18%             |
| Hand-drawn’ using, for example, inking tools | 18%             |
| **Within Word 2007**         | **9% (± 2 tutors)** |

The following comments were typical.

- ‘I have had to draw diagrams out and put them in the post.’
- ‘Well... I got what I wanted but after considerable effort/time (if scanning etc was involved)!’
- ‘It has been time consuming. Initially to prepare the diagram and secondly to paste successfully into a textbox. It has been adequate, but the single factor that has lengthened my marking time.’
- ‘I have produced diagrams in Word for other situations so could do so but it takes a lot of time.’

Many tutors would prefer that diagrams were provided in the tutor notes: ‘The remaining TMAs all require several sketches; I may copy and paste these from the electronic tutor notes if necessary.’

Tutors were made aware of how to download the Word 2007 Maths Add-In, which draws graphs derived from user-input equations. However, no comments were received about it and there is no evidence from the eTMAs that it was used.
Word 2007 and its mathematical features

The mathematical features have been used by over half of the tutors, with generally favourable comments, but some frustrations too.

- ‘Typing equations in Word 2007 is fine.’
- ‘The maths typesetting in Word 2007 is relatively easy to use.’
- ‘I still have a lot to learn about Word 2007 – it is a bit different from older versions of Word, but I have not regretted taking the plunge and following the advice to replace my existing version.’
- ‘The equation editor in 2007 is not easy to use especially when we need to use the notation of MST209 for vectors.’
- ‘The mathematical tools in Word 2007 are very frustrating if you use them from the menu. If you select, for example, the index format, the cursor is outside the template, and has to be moved back twice to start writing a power. In Equation editor you were at least set up with the cursor in the obvious place.’

There were concerns about the robustness of Word 2007 and in the second survey, only half the tutors rated it as reliable and stable. Several reported it crashing (causing tutors to lose their annotations), or running unbearably slowly. ‘I’ve found that Word 2007 generally takes a much longer time to open a document than did Word 2003, occasionally crashing in the process and requiring a reboot.’ ‘It takes a long time to open and scrolling takes a long time as well.’

Several factors seem to be at play including the type of computer and / or operating system, whether the document contained embedded images and the mix of marking tools and features used by the tutor. ‘Word 2007 is very buggy and frequently crashes when I open other documents I use. This means I need two versions of Word. Word 2007 is also slow on older machines. Now that I’ve just started using a Vista machine with loads of memory, Word 2007 loads a lot faster, but the bugs haven’t gone. However, I’m a fan of the maths package in Word 2007 and marking maths TMAs produced using Word 2007 is so easy!’ One tutor reported that Word 2007 improved after installing Office 2007 Service Pack 1.

Some tutors had problems with eTMAs which were prepared originally in Word 2007 by the student, as their comments and annotations (whether in Word 2007 or inked) could interfere with the student’s formatting and any automatic numbering. [See final comment under Types of file: Within Word 2007.] Others see it as an advantage to be able to insert space in a student’s response: ‘I sometimes like to embed my own solutions, and the eTMA system is very convenient for putting these in an appropriate position’.

A particular issue arose when students were using Word 2007 to produce their TMAs, but using Math Type fonts, rather than the Word 2007 built-in mathematical facilities, to create notation. These symbols then appeared as empty rectangles to the tutors upon opening the eTMA (which would have passed without modification through the maths eTMA processor). This can be rectified by ensuring that the tutor has installed the Math Type fonts since installing Office 2007. The particular students were also encouraged to learn how to use the mathematical features of Word 2007 and to read the MOL-produced guide on those features.

Some tutors used the insert textbox button on the MOL marking ribbon, whereas others saved a customised textbox and then either typed directly into this or pasted in comments from another document. ‘I liked making comments in textboxes and felt I could be more expansive than on scripts because I could reduce the typeface if necessary. The ability to save such comments will be very useful.’ Textboxes are essential for adding comments on eTMAs received as embedded images, allowing the tutor’s comment to be positioned next to the student’s solution. However, there were technical problems with textboxes.
• In Word 2007 documents containing embedded images it is very difficult to position textboxes precisely (i.e. so that relate to the relevant part of the student’s work) without a lot of time-consuming fiddling. [It was hoped that the MOL marking tools would overcome this problem.] ‘I won’t bother with the other textboxes I so lovingly designed. One with a nice big tick, one for a comment or helpful hint, one for error in working.... It takes too long to place them.’

• In editable Word 2007 documents it can be difficult to place textboxes without obscuring part of the student’s work. Even if they appear to be appropriately placed in the eTMA when it leaves the tutor, this may not be the case for the student when they open the marked eTMA in Word 2007 with their own local settings. One solution to this would be for all marked eTMAs to be returned as PDFs, perhaps accompanied by the Word 2007 version (though this would increase file sizes for tutors to upload, and for students to subsequently download).

• There were a few reports of textboxes not expanding to accommodate mathematical symbols, such as $\sum$, which extend below the text line. Other reports indicated that although everything looks alright in Word 2007, when the document is subsequently saved as PDF the bottom part of such symbols is obscured by the textbox.

A more detailed list of the tutors’ comments on Word 2007 is given in Appendix A. It is worth noting that the current version of Word for Macs does not have the mathematical features as found in Word 2007 for Windows.

Inking

Use of inking facilitates marking in a similar way to paper marking, and all but a handful of the tutors tried inking at some stage, with two using it exclusively. Generally, the concept of inking was liked:

• ‘A handwritten tick or mark flows naturally from reading through, the insertion of anything takes time.’

• ‘After my short and limited trial, I feel that I shall be able to do what I want to do as ‘inking’, now. At the moment, I’m considering writing marks by hand, and maybe adding odd words, which will be quicker to ink than to set in a textbox or callout.’

About a dozen were still using inking at the end of the trial. Initially nearly half found it very helpful, but a quarter found it not helpful - the divergence in views is likely to be due to different tutors using different hardware / software combinations for their inking. In the main tutors were using their own computer, which for a handful was a Tablet PC. The rest were all supplied with a small plug-in graphics tablet.

Those with reliable inking technology tended to rate it highly and found it less disruptive to their marking: ‘I am using a tablet pc and the inking facility makes marking really easy.’, ‘I have a tablet laptop. This makes marking eTMAs as easy as marking paper TMAs.’

Those using the plug-in graphics tablet had more problems; its success was dependent on the associated software. Tutors who responded that they were confident using the plug-in graphics tablet and also confident using the Meander software rated inking as helpful. Tutors who did not rate inking as helpful were exclusively using plug-in graphics tablets and responded that they were not at all confident in using it. Tutors using the plug-in graphics tablet generally agreed that the results were not worth the effort involved.

• ‘The tablet is useless with its software, so that had to be abandoned.’

• ‘I have had a go with inking before and I don’t seem to be getting any more controlled with my freehand comments (it always comes out much bigger than I expect and a lot ‘wobblier’).’
• ‘The Wacom tablet supplied is far too small for us to make good, legible, comments - a tablet of A4 size would be better. A tablet PC, where you are writing (inking) on the actual image would be far easier to use.’
• ‘I have not used the Inking Tools as I have been unable to master the use of these at any level to be worthwhile.’
• ‘I have given up trying to use the inking tools and the tablet, although I would like to be able to use them and would find them really useful if I could get them to work.’

Those tutors who experienced problems with the hardware or software associated with inking (usually with the plug-in tablet) tended to report that use of inking tools increased marking time. Interestingly though, the average response on marking times from the half-dozen tutors using a Tablet PC wasn’t any better than the overall average.

One tutor used ‘Pegasus Note Taker’ to insert ticks, marks and comments, with reasonable success.

**Mixed-mode**

Some tutors preferred to use a mix of inking and typeset annotations throughout, but often commented that going back and forth between the two took additional time and / or was too fiddly.

• ‘I now use exactly the same marking methods (typed comments/solutions in textboxes, arrows, inking for underlining/highlighting) for all eTMAs, in whatever format I receive them; I found that trying to edit within Word completely messed up the student’s formatting. Of those I’ve received, the majority have arrived as images (either handwritten and scanned, or produced with a different WP).’
• ‘When switching to inking two mouse clicks are needed. When switching between inking and insertion of textbox mode (on scanned - image documents) this takes time and the position on the page is sometimes lost. Dragging textboxes to the position on the page where they are needed takes a significant time. Also getting the textboxes / callouts in to the correct size for the position is time consuming (particularly in documents that consist of scanned images.’

One tutor provided a concise summary of their mixed-mode approach to marking: ‘I slipped into the habit of using inking for small marks, e.g. ticks, crosses, ringing, and part marks on both types of document. I used ‘draw a textbox’ for comments and for pasting ready prepared diagrams or text because it was easy to place it exactly where I wanted it. I used arrows to direct my comments. I used my own question total textbox (that I had to drag from the top left corner for PDF documents), that I could annotate as required with comments such as ‘well done’.’

**Examples of marking approaches**

**Direct typing and maths**

\[ \Phi(p^k)|p^k = \sum_{\text{all primes}} \phi(p) \mu^2(p) \]

You have got these upside down, see note above on notation

L.H.S. If \( p \) is prime then \( \phi(p^k) = p^{k-1}(p-1) \)
So \( p^{k-1}(p-1) \) no, \( \varphi(p^k) \) doesn’t divide \( p^k \).

\[ \frac{p^k}{\varphi(p^k)} = \frac{p^k}{p^{k-1}(p-1)} = \frac{p}{p-1} \]

R.H.S. For all primes \( \mu(p) = -1 \)
\( \mu^2(p) = |\mu(p)| = 1 \)
\( \phi(p) = p - 1 \)
Direct typing (with track changes)

\[ H_1 \text{ is a group.} \]

<table>
<thead>
<tr>
<th>( H_1 )</th>
<th>e</th>
<th>c</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>e</td>
<td>e</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>c</td>
<td>c</td>
<td>d</td>
<td>e</td>
</tr>
<tr>
<td>d</td>
<td>e</td>
<td>e</td>
<td>c</td>
</tr>
</tbody>
</table>

\[ \checkmark \checkmark \]

\( H_2 \) is not a group because it contains the element \( f \), which is not in \( H_2 \), not well expressed, \( cub = f \), so \( H_2 \) is not closed \((- \frac{1}{2})\)

\( H_3 \) is not a group because it does not contain an identity element. \( \checkmark \checkmark \)

\( H_4 \) is a group.

<table>
<thead>
<tr>
<th>( H_4 )</th>
<th>e</th>
<th>j</th>
</tr>
</thead>
<tbody>
<tr>
<td>e</td>
<td>e</td>
<td>j</td>
</tr>
<tr>
<td>j</td>
<td>j</td>
<td>e</td>
</tr>
</tbody>
</table>

5 \( \frac{1}{2} \)/6

Textboxes (one containing screenshot from marking solutions)

\[ b) \int \frac{\sin x}{1 + 3 \cos^3 x} \, dx \quad u = \tan^{-1} \left( \frac{\sin x}{\cos x} \right) \]

\[ = \frac{1}{2} \int \left( 1 + \tan^2 x \right) \cos x \, dx \]

\[ = \frac{1}{2} \int \left( 1 + \frac{\sin^2 x}{\cos^2 x} \right) \cos x \, dx \]

\[ = \frac{1}{2} \int \cos x + \frac{\sin x}{\cos x} \, dx \]

\[ = \frac{1}{2} \cos^2 x + \ln | \tan x | + C \]

\[ = \frac{1}{2} \cos^2 x + \ln | \tan x | + C \]

(ii) \( \text{Take } u = 3 \cos x. \text{ Then } du/dx = -3 \sin x, \text{ and so} \)

\[ \int \frac{\sin x}{1 + 9 \cos^2 x} \, dx = \frac{1}{3} \int \frac{1}{1 + u^2} \, du \]

\[ = -\frac{1}{3} \arctan u + C \]

\[ = -\frac{1}{3} \arctan(3 \cos x) + C. \]

Here you have copied the question down incorrectly ad your method is not valid anyway! Please see solution below.

0/5

Question 3:

5/10
Callouts

The axiom 63 of Inverses (Hbk p 25 item 3/1) is held as for addition the inverse of \( x \) is \(-x\) (Hbk p25 item 3/6) and \( x \cdot 0 = 0 \). Hence the group contains inverse elements for each element.

The axiom 64 of Associativity (Hbk p 25 item 3/1) is held as addition is associative (Hbk p25 item 3/7).

Hence \((\mathbb{Q}, \cdot)\) is a group.

Question 2

(a) The rotation of \( F \) about an axis at right angles to the plane of the base of \( F \) passing through the vertex 1 of \( F \) produces the following symmetries:

Identity element "e":

\[
\begin{array}{ccccc}
1 & 2 & 3 & 4 & 5 \\
1 & 2 & 3 & 4 & 5 \\
\end{array}
\]

Rotation anticlockwise through \( \pi/2 \) "r":

\[
\begin{array}{ccccc}
1 & 2 & 3 & 4 & 5 \\
1 & 3 & 4 & 5 & 2 \\
\end{array}
\]

Inking

\[
f : \mathbb{R} \to \mathbb{R} \\
f(x) = \begin{cases} 
\cos(\pi/x^2) & \text{if } x \neq 0 \\
0 & \text{if } x = 0
\end{cases}
\]

Prove that \( f \) is discontinuous at 0 using sequential definition of continuity.

Need to find a sequence \((x_n)\) in \( \mathbb{R} \) so that:

- \( x_n \to 0 \) as \( n \to \infty \)
- \( f(x_n) \to f(0) \) as \( n \to \infty \)

As \( f(0) = 0 \) and \( f(x) = \cos(\pi/x^2) \) if \( x \neq 0 \), need to choose sequence \((x_n)\) where \( \cos(\pi/x_n^2) = 1 \) as this is the highest value \( \cos(\pi/x^2) \) will take.

So \( f(x_n) = \cos(\pi/x_n^2) = 1 \) for all \( n \) and \( f(x_n) \to 1 \neq 0 \) as \( n \to \infty \).

\[
\begin{align*}
\frac{\pi}{x_n^2} &= \frac{\pi}{n^2} \\
\cos(\pi/n^2) &= 1 \quad \text{when } x = \pm \sqrt{n} \\
\end{align*}
\]

Let a be the form \( 2\pi m \) (\( m \) an integer) and \( \cos a = 1 \)

Then \( \cos(\pi/x_n^2) = 1 \) whenever \( x_n = \pm \sqrt{n} \) for \( n \neq 0 \\
\]

So let sequence \( x_n = \frac{\sqrt{n}}{\sqrt{2}n} \)

then \( f(x_n) = \cos(\pi/x_n^2) = \cos(\sqrt{2}\pi) = 1 \) for all \( n \).

\( x_n \to 0 \) as \( n \to \infty \)

\( f(x_n) \to 1 \neq 0 \)

\( f \) is discontinuous at 0.

To gain another mark you should justify this, eg "as \((x_n)\) is a multiple of a basic null sequence."
Marking tools

In general, the idea of the MOL marking tools was welcomed, especially quick insertion of marks, automatic totalling, and insertion of stored comments. Tutors also appreciated the potential time-saving offered by the marking tools. However the marking tools were not used as extensively as hoped, primarily for the following reasons.

- They were rolled out after tutors had already started experimenting with alternative methods of marking.
- Initial problems with some of the tools e.g. slowness in the marks addition tools and instability on the page manipulation tools, were reported on the online conference and dissuaded some tutors from trying the tools, as seen from the regular reports. ‘I’m afraid I haven’t downloaded the MOL ribbon as I’m scared of making my computer crash (this is partly as I’ve read some messages that seem to indicate people have had problems with the ribbon, but mainly my natural fear of adding on anything which seems unnecessary - I’m sure the ribbon is very useful, but I can get by without it. So far.).’
- Documentation was circulated electronically and feedback suggests that a hard copy may be preferred.
- Having to update Windows before installing the tools was possibly a barrier to trying them.
- Lack of available time to try something else new. ‘For eTMAs received as images, I’ll probably save time by giving up on the marking tools at an earlier stage :-('.
- They are not considered necessary. ‘not really necessary for M248 TMA01. Just inserted my comments and marks using Word in red type.’

As the first generation of MOL-developed marking tools was not sufficiently stable or straightforward to use tutors tended to abandon them: ‘I find the marking tools are too cumbersome so I rely on the pen for ticks and marks (although messy) and insert textboxes for comments’. Attempts were made to improve the tools but, by the time these were ready, the trial was over half way through, and the tutors had either got out of the habit of using the tools, or else used only a very small subset.

The mark insertion tool was the most popular, and some tutors persevered with its use well into the trial. The insertion / repository tool proved difficult to use because of positioning the resulting textboxes, though many tutors sought alternative ways of storing and re-using comments, solutions, etc. The document manipulation tools were used very little, but then only a few eTMAs necessitated such re-formatting.

At the end of the trial most tutors indicated that at least some functionality of the marking tools would be beneficial in terms of time, if working well and efficient to use. The most popular tools in this respect were ‘single-click’ insertion (and automatic totalling) of marks; ‘single-click’ insertion of textboxes; re-use of comments and diagrams from repositories.

Other improvements to the marking tools were suggested:

- Facility to include mathematical notation on PT3.
- Automatic entry of marks onto the PT3.
- Make visible the ‘edge’ of embedded images.

Document manipulation tools

Feedback from the few tutors who used them indicated that the document manipulation tools were found to be useful. ‘I managed to unlock and swap round pages although I did get pages mixed up in my enthusiasm. That seemed to work well.’

However, in the first survey 72% of tutors responded that they were not confident using these tools and the remaining 28% were only moderately confident. It’s most likely that these tools were not needed for the majority of eTMAs so lack of practice led to general lack of confidence in using them.
**Insertion tools**

The insertion tools place ticks and other symbols in the document within textboxes. They are therefore subject to exactly the same problems of positioning described above for textboxes. Tutors also found adding and formatting ticks to be unsatisfactorily slow. This was perceived as a bigger problem when working with embedded images since textboxes must be used.

- ‘Marking tools unacceptably difficult to use effectively and with speed. In particular not being able to place comments, ticks (too small) etc where you want them.’
- ‘I was pleased with the way the ticks, crosses, call-outs and textboxes worked’
- ‘I was getting very frustrated about where the textboxes, and particularly the question mark boxes were entering into the document (sometimes it was several pages earlier than the page I was viewing).’
- ‘I tried the ticks and I got a bit frustrated with the usual problem of dragging the textbox to where you need it. Very time consuming. I then found that sometimes I left the outline behind. I would like a larger green or purple tick that stands out, but I can add to the quick access toolbar anyway.’
- ‘As you know, adding ticks is a nightmare!’

**Marks insertion tools**

Those tutors who wanted to use the MOL marking tools were particularly enthusiastic about the mark insertion and totalling facility, and hence were very disappointed when this didn’t work as well as expected. Technical problems with Word 2007 led to insertion becoming slower and slower and, on many occasions, ultimately grinding to a halt.

- ‘The marks worked well, although I would prefer a proper fraction.’
- ‘At present I find them unusable; they would be very, very useful.’
- ‘It’s magnificent when it works! Please continue to work on it - it is a real bonus having something that adds up part marks (though maybe my mental arithmetic skills will die as a result). I like to add a comment to the overall question mark and I found this difficult to do in the existing mark box - but this is a small point because I can always add a comment in another way.’
- ‘I marked my first real TMAs today and was very excited about using the mark tool that is supposed to keep count of the part marks for a question. Question 3 had about 8 parts and the total score tool just seized up my computer and then crashed it (the laptop). Right, I thought, let’s have another go, another crash. Right, I thought, I’ll just add up the marks myself. I’m marking q 4 by now. Now the mark tool is taking 1 minute to deliver its neat little textbox, now it’s taking two minutes. I give up.’
- ‘Crashed Word when I was demonstrating the Marks Insertion Tools at R09 Staff Development meeting.’
- ‘I had the same problem. I like to give part marks where marks have been lost and as there were a number of parts the system got slower and slower until I gave up. I never got to it crashing but I suspect I was nearly there.’
- ‘Unfortunately I found that inserting part marks and then question totals was extremely slow, and it seemed to get slower until Word crashed.’
- ‘I have had the same problem with the marking tool.’
- ‘It never actually crashed, but it was unusable for the last question.’
- ‘Some people are finding them slow and it’s crashing the computer. I’m not finding that. Maybe it’s a memory issue or something like that, that could be overcome?’
- ‘I have designed my own question total box with the facility to write an overall comment if I wish, but still trouble placing it where I want it.’
Repositories for comments / equations / diagrams / solutions

In general, the facility to have a repository of comments was liked, irrespective of the eTMA format. It was noted, though, that it was unnecessary to have multiple repository categories. Despite agreeing that the repositories and insertion tools are useful, tutors did not feel confident in using them. Again, this could be due to the small numbers of assignments being marked electronically and consequent lack of practice. There were some misconceptions about their purpose. In particular, tutors may not have been aware that comments can be added / deleted or edited: ‘Is it the list of pre-canned comments? Don’t use them.’ The biggest barrier to using the repositories was that inserted textboxes were not inserted at the current curser position. Instead they appeared at a set position at the top of the page, but not necessarily on the current page - it was likely to be the page where the last comment was inserted.

However, the single issue most commonly identified to potentially reduce e-marking time was the ability to cut and paste comments. Some tutors recognised the potential investment of setting up a repository of comments at the outset. Several tutors developed their own version of the repositories, some choosing to have a separate Word document open into which they copied and pasted comments; others chose to use the clipboard facility (though additions to the clipboard are not retained once Word 2007 is closed). Several reported that it was quicker to use, and specifically to position, textboxes they generate themselves (rather than those from the marking tool ribbon).

- ‘I tended to use empty Textboxes or Call outs for comments and corrections. Thus, I found myself re-typing the same comments or correction on more than one script. In future I will add any comment or correction to Marking Tool ‘Insert Comment’ as I go along while marking each assignment. Added comments will be reviewed and deleted, as appropriate, after marking all assignments for a particular TMA.’
- ‘I also spent a bit of time while marking the first few TMAs adding comments to the comments database. Once I’d done all this though, I find that the time saved not fiddling with the formatting of the textboxes and flicking between open files is quite significant.’
- ‘Re insert comment etc. - have used this to some extent (with my own saved comments, and diagrams copied from TN PDFs using snapshot tool) but didn’t feel the need for all the different categories (comment, solution, equation, diagram)- less fiddly to have all the stuff relevant to a particular TMA in one place. Haven’t used any of the comments etc. provided.’

It was suggested that the repositories of comments, solutions and diagrams need to be organised by TMA question, so that they are easier to find. There may then be the potential for comments etc to be re-versioned when similar TMA questions appear in subsequent presentations. It may be helpful to tutors if this were organised by the Course Team. There is, however, concern that there is a temptation to provide model solutions rather than tailoring feedback to the individual student.

Learning curve

eTMA system

Initially tutors reported difficulties in learning how to use the main eTMA system although, by the first survey, all except one tutor declared themselves confident in collecting, opening, saving and returning eTMAs and producing the PT3, with over 40% ‘very confident’ in each of these: ‘I am now confident using the eTMA system of collecting and returning.’ Those who were not ‘very confident’ commented about the number of procedures to learn and remember and felt that they still had to refer to the guide when collecting and returning the TMAs.

- ‘Remembering how to do things! [Or looking them up.] [takes time].’
- ‘I felt quite apprehensive at the start of the trial – and the amount of software to download and familiarise myself with was daunting. I had no experience at all of the eTMA system, but was pleased that I found this reasonably straightforward to learn.’
• ‘I only discovered for this set of eTMAs that it is possible to mark & save several assignments that can then be zipped and returned together.’
• ‘Returning eTMAs makes me nervous - I always end up double checking the zip archive contains what it should contain!’
• ‘With so few TMAs coming in I often have to refer to the guide when collecting and returning the TMAs.’

Tutors were asked to rate their confidence from 1 (not at all confident) to 5 (very confident) in the following aspects.

<table>
<thead>
<tr>
<th>Confidence in handling maths eTMAs</th>
<th>Overall ranking</th>
<th>May</th>
<th>July</th>
<th>October</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collecting eTMAs</td>
<td>2</td>
<td>4.13</td>
<td>4.65</td>
<td>4.55</td>
<td>4.44</td>
</tr>
<tr>
<td>Opening and saving documents,</td>
<td>3</td>
<td>4.13</td>
<td>4.57</td>
<td>4.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Dealing with multiple documents / formats within individual TMAs</td>
<td>8</td>
<td>3.33</td>
<td>3.5</td>
<td>3.73</td>
<td>3.52</td>
</tr>
<tr>
<td>Producing the PT3</td>
<td>1</td>
<td>4.17</td>
<td>4.57</td>
<td>4.68</td>
<td>4.47</td>
</tr>
<tr>
<td>Working with maths eTMAs (embedded images)</td>
<td>7</td>
<td>3.45</td>
<td>3.74</td>
<td>3.95</td>
<td>3.71</td>
</tr>
<tr>
<td>Working with maths eTMAs (Word)</td>
<td>6</td>
<td>3.73</td>
<td>4.09</td>
<td>4.14</td>
<td>3.99</td>
</tr>
<tr>
<td>Manipulating documents (using the MOL manipulation tools)</td>
<td>9</td>
<td>1.83</td>
<td>2.15</td>
<td>1.9</td>
<td>1.96</td>
</tr>
<tr>
<td>Converting to PDF</td>
<td>4</td>
<td>4</td>
<td>4.48</td>
<td>4.59</td>
<td>4.36</td>
</tr>
<tr>
<td>Returning eTMAs</td>
<td>5</td>
<td>3.83</td>
<td>4.39</td>
<td>4.27</td>
<td>4.16</td>
</tr>
</tbody>
</table>

Responses to the first survey did not indicate any correlation between confidence in handling (which was dealt with separately from marking in the survey) eTMAs in this trial and previous experience of the eTMA system. The added complexity of dealing with multiple files and formats, embedded images and editable Word 2007 documents, and the corresponding selection of marking facilities, seemed to militate against any advantage for those with previous experience.

E-marking

By the time they were responding to the first survey (May) most tutors had made reasonable progress along their learning curve, and found procedures and marking facilities which suited the way they mark and their TMAs. However, to get to this point was not a trivial activity: ‘I spent a lot of time on TMA00 working out how I was going to mark ... this was time well spent.’ And, at least for some, it is a long process: ‘I am not yet confident enough to do any of it without referring to the various guides at every step and double-checking before clicking.’; ‘I think that I could get used to the marking, though at first I was concentrating so hard on inserting textboxes etc that I made mistakes in my comments! This should improve with practice’.

In the initial stages many tutors experimented with the various tools available, including the marking tools developed by MOL. Some tutors very quickly settled into an efficient approach for them, which tended to be straightforward insertion of typed comments (especially on courses which don’t require much mathematical notation), or inking (for those for whom this was working well). Other tutors took the opportunity to experiment and to test the different tools on offer. ‘I want to do the best job I can; not only marking accurately and providing useful comments / corrections etc but also in the overall style and presentation of what I add to the student's script. If I know how to do it and make it look good I'll do it, even if this takes a long time, more than is necessary to do an adequate job.’ In part, this may be because this was a trial and the tutors were receiving payment, but any tutor engaging with marking maths eTMAs for the first time is likely to need time to explore the marking approaches and to experiment with what works best for them and their type of assignment.

In the first tutor survey, 20 tutors considered themselves at least moderately confident in using Word 2007 in general, and 14 tutors considered themselves at least moderately confident in using the mathematical features of Word 2007.
By the second survey, only a few tutors indicated that they were not confident in using Word 2007. However, confidence in using Word 2007 was generally slightly lower among those who used it the most, and this was also true for those using the mathematical facilities of Word 2007. This may be due to one or more of:

- tutors had a low opinion of their skills as they became more aware of the extent of Word 2007’s capabilities;
- if Word 2007 was found to be unstable tutors’ confidence in it may have been eroded;
- it takes more time to become fully proficient in using multiple aspects of Word 2007 than afforded by this trial.

Those who made considerable use of inking rated it highly, and gave higher ratings for confidence in its usage than the corresponding ratings for those using typesetting.

<table>
<thead>
<tr>
<th>Confidence in marking maths eTMAs</th>
<th>Overall ranking</th>
<th>May</th>
<th>July</th>
<th>October</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using Word 2007 in general</td>
<td>2</td>
<td>3.43</td>
<td>3.86</td>
<td>3.82</td>
<td>3.70</td>
</tr>
<tr>
<td>Using the mathematical features of Word 2007</td>
<td>4</td>
<td>3.05</td>
<td>3.53</td>
<td>3.06</td>
<td>3.21</td>
</tr>
<tr>
<td>Using inking tools</td>
<td>1</td>
<td>2.8</td>
<td>3.77</td>
<td>4.08</td>
<td>3.93</td>
</tr>
<tr>
<td>MOL insertion/repository tools *</td>
<td>5</td>
<td>2.62</td>
<td>2.86</td>
<td>2.8</td>
<td>2.76</td>
</tr>
<tr>
<td>MOL mark insertion tool *</td>
<td>3</td>
<td>2.91</td>
<td>4</td>
<td>3.75</td>
<td>3.55</td>
</tr>
</tbody>
</table>

* Far fewer tutors were using these as the trial progressed.

In terms of marking, by mid-trial, most had settled into a particular approach, or mix of approaches: ‘I have settled into a routine so I probably won’t change what I do.’ Fewer tutors were happy to continue to experiment with the various facilities available to them. Some recognised that the investment of time would become more worthwhile when more of any one TMA is submitted electronically, though others found this prospect daunting. ‘It takes time to become familiar with this form of marking. I am sure that when I have marked a hundred TMAs many features will become second nature.’

Confidence in equation editing waned slightly towards the end, possibly though lack of regular practice of using Word 2007’s mathematical features. There was a difference of opinion as to whether having previous experience of using LaTeX was a help or a hindrance:

- ‘Maths typesetting in Word 2007, which thankfully I found easy as I use LaTeX.’
- ‘Maths typesetting in Word 2007 which I am getting very familiar and happy with. I’m very glad that I can touch type and use TeX both of which help me here I think. My fingers now automatically type ALT= without my having to think!’
- ‘People who use LaTeX have to use a non-WYSIWYG system where \epsilon is the epsilon letter/sign, etc., so they get proficient at this and can even write and recognise ascii text written in emails in this manner. In Word2007 the signs are taken from drop-down menus and this can take a long time. There are many shortcuts such as using \epsilon which work, but it’s harder for a Word2007 to learn these. Perhaps a list of common short-cuts might be useful, especially when they relate to TMAs that are issued.’

The tutors worked extremely hard to replicate the quality of their work on paper, and to find approaches which facilitated this. One or two realised that if eTMAs were adopted permanently that they might need to re-think their approach to marking (whilst maintaining the quality of their feedback). ‘I believe that I should investigate different ways of marking, rather than just replicate what I do with paper TMAs.’

In the first survey, 17 tutors found it more complex (10 significantly more) to mark (that is annotate with comments and marks) eTMAs than paper TMAs, the rest found it about the same. Although a couple of tutors reported an improvement mid-trial, by the end all but two found eTMAs more (or
significantly more) complex than paper TMAs. There is no difference in opinion between those who primarily inked and those who primarily typeset their annotations.

**Quantity and quality of feedback**

Initially tutors perceived their comments to be of at least the same quality and quantity as those on paper TMAs, and this was borne out by the comparison of marked work returned to the University.

Throughout the trial tutors felt that they gave about the same number of, or just slightly fewer, comments as they would on paper TMAs, but there is some evidence that tutors weren’t including pre-prepared solutions in this count. Comparing the length of their comments to those typically given on paper TMAs, these started off as ‘about the same’, but a few tutors reported ‘longer’ mid-trial, but ‘slightly shorter’ by the end. This probably mirrors the tutors’ experience of becoming accustomed to e-marking, but then wanting to find ways to reduce marking times. Factors such as helpfulness and legibility of comments stayed fairly constant. In the length and helpfulness of their PT3 comments most tutors felt that there was no difference to paper TMAs.

There doesn’t appear to be any correlation between the tools being used and the differences in the quantity and quality of the feedback, as perceived by the tutors. However, tutors did generally think that the legibility of comments was better on eTMAs, although this was not so much the case amongst those using a Tablet PC (who also tended to think that they were making fewer comments than on paper). Comparison of eTMAs and paper TMAs suggests that inked comments on eTMAs tend not to be as legible as handwritten comments on paper.

By the middle of the trial, some of the non-qualitative responses to survey questions suggested that practice and perceptions were beginning to change:

- ‘In practice it’s fewer / shorter comments for embedded image TMAs and more / longer comments if I can just type them straight in.
- ‘I make fewer spontaneous comments - like ‘just what is needed’, but perhaps that is a good thing.’
- ‘They do take a long time to mark but I have tried not to cut down much on my comments. Maybe I should.’
- ‘Over time, I have decided that beauty of the finished document just doesn’t matter, so I have taken shortcuts which mean I am more willing to spend time making the appropriate comments.’
- ‘I feel the quality of my teaching approach, which I try to personalise for each student, is somewhat inhibited, though, by the need to use the computer to mark.’
- ‘I’ve stopped writing ‘ticks’ on the student scripts as inking didn’t work for me and I haven’t found a good technical way to write the ticks, that isn’t going to slow me down further.’
- ‘I used the page insert facility this time and copied chunks of the tutor notes (not something I usually do).’
- ‘I made greater use of Insert comments both for use on the script and PT3. Although I continue to find this of limited value as the comments frequently require particular wording to suit each individual student’s error.’
- ‘My feedback to an incorrect question usually involves an explanation of how to do go about answering the question plus the answer. As this is quite difficult to type, I find this takes an inordinate amount of time. I also have found that I could cut down on this time if I had the solutions prepared ready to copy and paste, but this meant that the responses were less individualised.’

It became clear that generally tutors on the trial made great efforts to provide the same level of feedback as in paper marking, and increased their time spent on marking to ensure this. However, the increased marking times per TMA suggest that, in the long run, there would be pressure to reduce the amount of feedback or, at least, to make it less individualised. Many tutors recognised
the potential of re-using comments for reducing the marking time for eTMAs, but were concerned about providing feedback which isn’t personalised to the student.

Indeed, across the trial tutors perceived their eTMA marking to be slightly less personalised to individual students, although the rating did slightly improve in the later stages, though this may have been due to a change of perception rather than of practice. However, anecdotal concerns about ‘de-personalisation’ didn’t diminish as the trial progressed – indeed, the issue received more unsolicited mention in the third survey than in the previous two. Many felt that personalisation, and hence quality, will have suffered as they tried to cope with time pressures.

- ‘The temptation to just take a whole answer and start pasting it into each student’s script is very strong. Suppose a student makes a mistake on Q1(a), in the end you might tell them where they made a mistake, tell them what they should have done, and give references to the handbook or course material. The tutor notes have what they should have done, references to the chapters or handbook, and the marking scheme. So you end up writing out the equations from Q1(a). The next student might make a mistake in Q1(b), so you end up writing out Q1(b), and so on until you eventually have the whole answer written out. Then when any student makes any mistake in Q1 it’s tempting to just say, ‘this is how it’s done’ and cut-and-paste the whole solution.’

- ‘However there is a temptation to take all of the information stored from previous students and paste it in as extra information, which could lead to ‘supplying model answers’, which the course team does not want, and also lead to a ‘depersonalisation’, where instead of telling the student exactly where they went wrong, the entire section of the answer is just pasted in and the student told to refer to how it should have been done.’

- ‘It takes longer to add a comment, so I tend to miss out the frivolous ones, which make marking more personal.’

- ‘The ability to copy answers from the TNs, but that worries me, since it means I am not personalising my responses in the same way as I would on a normal TMA.’

- ‘Frequently given comments can be re-used, but still personalised.’

Some tutors also felt that (exclusive) use of typed comments may be perceived by the student as less personal [students were asked about this in the student survey]. There was also concern about the ease of accidentally sending the wrong comment to a student.

- ‘I think that the impersonal nature of the computer text makes me write more personally to students.’

- ‘I felt increasingly worried about misleading students into thinking that those comments were written especially for them individually. [...] A ‘good’ comment at the click of a mouse is not the same as a ‘good’ written out person to person.’

- ‘I use the pen for writing ‘excellent’ etc as I feel it is more personal.’

- ‘I ... don’t like generic textboxes with standard text (eg ‘excellent’) - I like to do each one individually. Apart from anything else, I’d be scared of inserting the wrong thing by accident and not noticing (once much gets automated I get confused).’

When re-versioning previously used comments, one tutor left changes in font formatting within the comment, thus making multiple use of feedback potentially more obvious to students. There was evidence of greater re-use of comments by tutors receiving the larger numbers of eTMAs.

There was little unsolicited mention of diagrams amongst the tutors’ comments, but they are perceived as a problem area.

- ‘Trying to highlight the precise location of the student’s errors and give him the correct answers / hints on answers (containing diagrams). There’s no way I can do this electronically as well as I could with pen and paper. This was the first TMA when I really felt the student was getting a sub standard service. I may yet advise him to send the rest by post.’
‘The other issue was that I wanted at one point to add in my own hand-drawn diagram (not Maple generated, which I could have done quite easily I think) and I couldn’t do this. I can’t get inking to work on that wretched Wacom thing, I can’t get my PC Natetaker to work on Vista and I don’t have a scanner. So I’m going to draw the diagram out at the next tutorial – fortunately I know both students well and know they will attend. This is also an issue in that I would normally have annotated the specimen solutions (see below) by hand, making them more personal for the students, and I couldn’t do that easily either.’

Some tutors appreciated the ‘extra’ space available on the online PT3 form, but some found it frustrating not to be able to include mathematical notation or text formatting on it.

‘I also find the PT3 form slightly restrictive because it’s not possible to use formatting of any type (I like to underline or embolden for emphasis), or use any mathematical symbols or equations that might occasionally come in handy.’

‘One disadvantage: lack of ability to format or use symbols on ePT3.’

‘I use a soft PT3 [i.e. the one that can be used for paper TMAs] for all my courses and the marking tools – insert comments, insert equations are very useful on the PT3s as here I do repeat comments often and may have 15-20 PT3s to write in one batch. I use equations etc on these which I cannot on the PT3 that is submitted through the eTMA system.’

There was no indication of any particular effect of the MOL marking tools on the quality of comments. Some tutors had started to establish ways of marking before they became available, and from the eTMAs themselves it isn’t possible to distinguish use of the MOL marking tool repositories from other re-use of comments.

**Types of file**

**Within Word 2007**

Some tutors, especially those exclusively using inking, preferred working with TMAs consisting of embedded images, whereas others favoured editable Word documents. Editable Word documents were marginally preferred overall, but this may be because the tutors were encouraged to use Word 2007, found it difficult to use its annotation facilities with embedded images, and generally didn’t have reliable inking technology. However, some tutors didn’t like editable documents as their insertions could interfere with the layout and formatting of the student’s work.

‘Time for the two submitted in Word 2003 was appreciably shorter than that for the two I received as images – one handwritten and scanned, one created in another WP.’

‘Native word 2007 documents are dramatically easier to mark than “embedded images” documents, especially if the student uses Word 2007 maths facilities (rather than Mathtype etc.). There are two reasons for this: the first is that the document ”expands” as you type comments, so you are not restricted to the student’s layout, and the second is that it is very clumsy to annotate an embedded images document.’

‘I found that when marking Word2007 documents I ended up destroying my students’ nice formatting of equations, deleting their work without realising, creating new pages with not a lot on them, etc.’

‘I find eTMAs produced by the student in WORD 2007 very hard and irritating to mark. The equations in particular jump around and become unformatted when I try to use ink annotations. (I have a tablet pc.) I find I don’t like eTMAs that the student has written in WORD 2007. Indeed, they are such a nuisance that I have resorted to first converting them to PDF files, and then using PDF annotator to mark them.’

‘It is a curious thing but I have found the most awkward / risky assignment to mark was the one that was written using Word 2007, and submitted as that.’
‘I have only had embedded images and I prefer this to word processed work as it has more character.’

‘I prefer marking them because I can’t get the textboxes to work on Word documents and also I seem to destroy the students’ beautiful typesetting. So embedded images seem safer to me.’

‘Two submissions were images embedded in .docx – these were more tricky to mark.’

‘Scanned documents with pages put into a Word 2007 document are very large and completely unusable.’

‘To me the biggest help in embedded eTMAs would be the ability to see the edge of the embedded image.’

‘We do not have the tools for the job, yet. I find that it takes at least twice as long to mark an assignment electronically. I have just spent 2.5 hours awarding 98 marks. It was a .pdf based file. One of the very frustrating things (for me) is the way that Word jumps around the pages. You may find a pasted image almost anywhere on the script, and it can take a lot of time dragging it to where you want it.’

Over half the tutors indicated that they felt more confident in dealing with one format of Word document (embedded images or editable Word) than the other. There is a weak inverse correlation in the responses in that those tutors who were confident in dealing with eTMAs with embedded images were less confident dealing with eTMAs in editable Word format and vice versa.

Some tutors offered their thoughts on TMA preparation by students: ‘As things stand, I could not recommend transferring M208 to eTMA format. The tools are not there to do the marking job properly, and scanning in TMAs is time-consuming for the students, particularly given size constraints. All students could be persuaded to use Word 2007 and its native mathematical processing, things would be completely different, and I would recommend use of eTMAs.’ Tutors who were not using inking extensively found they generally needed to use different approaches on editable and non-editable Word documents. Some liked to use standard Word editing features such as track changes or comments (from the Review ribbon), but found it difficult to do so effectively with embedded images.

‘Native Word 2007 documents are easiest, and I use track changes for these (as with standard eTMAs). It’s easy to add “written” comments, and Word 2007 makes it reasonably easy to add mathematical comments. Scanned TMAs are completely different, and my practice has changed. Now that I’ve discovered “filling” with spaces, I can write comments much more easily, and I’ve given up all kinds of “balloons”/textboxes.’

‘Most of the assignments that I have received have been converted from .PDF form. For such documents it seems to me that callouts and textboxes are almost the only way to comment. I should like very much to use inking, which I think would shorten the time needed for marking, but the Wacom tablet did not work on the assignments. On the odd assignment that I received in Word 2007, marking was so much easier, and being able to use track changes was very helpful both in terms of time taken and being able to make a small insertion more easily.’

‘My practice has changed during the year and according to type of eTMA. Native Word 2007 documents are easiest, and I use track changes for these (as with standard eTMAs). It’s easy to add written comments, and Word 2007 makes it reasonably easy to add mathematical comments. Scanned TMAs are completely different, and my practice has changed. Now that I’ve discovered filling with spaces, I can write comments much more easily, and I’ve given up all kinds of balloons/textboxes. Track changes is no help, and the easiest is simply to set the colour to red.’

Some tutors gave different forms (e.g. no ticks) or quantity of feedback on embedded images, as compared to on editable documents.
One tutor indicated that editable Word documents were not compatible with inking: ‘the inking tool which I use exclusively tends to alter the format of Word 2007 equations made using the new equation editor. I found it best to convert the document to PDF, and mark it using PDF annotator.’

**Embedded images**

In general the resolution of embedded images was thought to be acceptable, although there were a few comments about the difficulty of reading small writing and / or not having sufficient white space: ‘I have one student whose work was so hard to mark electronically (poor writing, so many errors that I needed to mark up so much of it) that I have had to ask him to submit by paper. I simply couldn’t do a good enough job electronically; I can’t highlight bits of embedded images (haven’t got inking to work) and I couldn’t put enough comments close to where I wanted them. The reverses of pieces of paper are great!’ Some concerns were raised about the quality of hand-drawn graphs, particularly where the accuracy of plotting etc was being assessed and gridlines weren’t visible.

**Multiple file types**

Dealing with multiple documents and formats had a mixed response in the first survey: about half the tutors were confident, 20% not confident and a third moderately confident. Some tutors who dealt with multiple file types throughout the trial did find them an inconvenience.

On courses which require students to use specific software, such as Mathcad, Maple, Minitab in some or all of their TMAs, some tutors preferred these to be delivered as ‘live’ files to facilitate checking, whereas others felt it best for such output to be embedded as images.

- ‘There’s also the point that if you want to run some code supplied by the student, eTMAs are by far the best way to do it.’
- ‘This is a Maple course and the Maple files came through unaltered so that I could execute them, so that worked well.’
- ‘Students are supposed to embed Mathcad documents within their main Word document, however they can send them separately if the tutor agrees. This seems to put the onus on the tutor to make the decision. Someone else reported their student spent 5 hours trying to embed their Mathcad documents, and one of mine posted their separately without even asking me. I can’t see a situation where I would refuse to allow a student to do this, knowing I have the power to let them and it might delay their submission. I feel it is unfair to some students if they take time and effort to embed. However I see the problem, it’s harsh to make it mandatory to embed in case some students have genuine problems, but if students are told they do not need to embed, then none will. On the other hand, in a case where the student sends separate Mathcad documents, I don’t think the tutor should be required to embed them. I did not, just referring instead in the main document to the ‘separate Mathcad files’. Of course this makes it harder for a monitor to see everything, but provided the comments in the main document are good enough, I don’t think that should be an issue. (The original Mathcad documents are preserved in the system for any unusual cases, e.g. checking for appeals, plagiarism, etc.)’

**Converting to PDF**

In most cases, once an eTMA had been marked in Word 2007, the tutor was required to convert it to PDF prior to return to the OU’s main eTMA system to enable students who didn’t have Word 2007 to read all their tutor’s annotations. This process was problematic to tutors for various reasons.

- Particularly at the beginning some tutors simply forgot to convert to PDF, and sent the Word 2007 file to students who then couldn’t read it fully. [Some tutors expressed the view that it was better to return both the PDF and the Word 2007 version of the marked TMA, so that both were held in the OU’s main eTMA system, even though this may cause confusion to students, at least initially. Others thought it better to return only the PDF version, but this
places extra demands on the tutor in ensuring that it is the PDF version they return, and in storing the Word 2007 version on their own PC. ‘Too easy to return marked work without first converting to PDF.’ ‘converting to PDF ... should be part of the conversion process behind the scenes.’

- The Word 2007 PDF add-in turned out to be unreliable, causing Word 2007 to freeze. Most tutors swapped to using one of the alternative stand-alone freely downloadable PDF creation tools, which also tend to produce smaller file sizes than the Word 2007 PDF add-in. ‘However when I came to create the PDF version to be sent back to the student, the PDF creator in WORD crashed. It got almost all the way through, and then stuck at processing tags (?) and then crashed badly. I have since tried it on other files, and the problem seems to be it doesn’t much like big files with lots of pasted in stuff, or equations created using MathType, when the student’s work was created using Word 97. It copes with smallish files.’

- In some cases the process of converting to PDF caused some notation to disappear: ‘other problem was when I saved as a PDF file, symbols got missed out, including minus and greater than or equal symbols, the plus sign had the vertical line twice the thickness of the horizontal I tried saving as Word 2003 document, it warned me that equations would be saved as images, but then even more was omitted.’

OU’s main eTMA system
The majority of the tutors were new to using the University’s main eTMA system, and in the first few months most reported difficulties, initially in collecting TMAs, but more significantly in returning files (e.g. omitting files, sending incorrect files, not first converting to PDF): ‘The worst bit is the eTMA system which I find quite clunky – nothing you can do about that’. The FileHandler, in particular, is not considered to be user-friendly for tutors (for example, students can make multiple submissions of a single TMA, but tutors can’t!).

- ‘I have not used the eTMA system before, so I believe I have a fresh perspective. The eTMA system gives me the feel of a system that could have a lot of improvements made, but will not as it is very usable, works, is ‘fit for purpose’, and hence once a tutor becomes familiar with it, they are very happy to continue using it without change. However it seems to me that the chance of making a mistake (e.g. returning the wrong document) is greater than for paper TMAs and I do not know how well the system will respond to non-standard situations (i.e. how easy it will be to correct any mistakes I might make).’

- ‘The eTMA system is already too fragmented.... (Collecting eTMAs from TutorHome, marking them in eTMA file handler and Word 2007, remembering to convert to PDF if required in Word 2007, zipping them in eTMA file handler, returning them from TutorHome.)’

- ‘The downloading, uploading, sticking files here, there and everywhere!’

- ‘The main eTMA system is not good on returning, cannot see progress of upload; one error and whole batch is rejected; system rejects long file names – I’ve got in the habit of zipping and returning a couple at a time even when I have a lot marked.

However, at least one tutor thought it no worse than the rigmarole of dealing with paper TMAs, especially in the case of a split TMA.

Later comments focussed on the inflexibility of the main eTMA system, particularly with respect to maths eTMAs for which the tutor had to convert the marked version to PDF and remember to return it and not the Word 2007 version. Some wanted these processes to be done by the system.

- ‘I have no problem with getting hold of the documents or handling them. It’s the nerve-racking time it takes to say it has returned the TMA successfully that bothers me!’

- ‘The OU system is terribly tortuous, having to go between so many windows.’

- ‘It is quite time consuming to make sure that docx documents have been moved out of the folder and PDVs have been created in their place before returning the etma to the system.’
Converting to PDF should be automatic where required, or there should be a prompt to remind you you haven’t done it. The File Handler should warn you if you are zip up a file that is open in Word. Once a file has been zipped, there should be some way for the File Handler to invoke Tutorhome to return the files. PT3 form is restrictive (and thus time consuming) as no formatting can be used, nor is it possible to type in any mathematics.  

- ‘Interacting with the OU File Handler, particularly when marked scripts are too large to be uploaded!’
- ‘The pain is in knowing that if I get it wrong, and send back the unmarked copy rather than the marked one, a very easy mistake to make, there is no way of resending it to the student.’

Details of the problems encountered with the eTMA system are given in Appendix A.

Test TMA00

Tutors were asked to comment explicitly about this facility because many maths courses (about half on the trial) have a split TMA01, so that students receive feedback on their mathematical work and presentation as early as possible. On paper the split TMA is handled by the tutor mailing the first part of the TMA directly back to the student: then the second part is returned, with the PT3, via the University in the standard way. The eTMA system can only facilitate split TMAs by the first part being submitted as TMA00, which excludes the student from submitting a genuine test TMA00 for them (and the tutor) to check that the processing and formatting are acceptable.

Tutors generally regard the TMA00 facility as useful (59% very useful) for students and tutors, especially when new to eTMAs. For tutors, the main benefit is to be to be able to practice returning eTMAs: ‘I found TMA00 useful only for me to sort out how to return TMAs, and to suss out the filing hierarchy (which should be in the OU literature). I shall not need to do this again (I hope).’ However, opinion is divided about whether TMA00 should be used for split eTMAs. Some think it’s a good idea, others think students would lose out by missing the opportunity to send a genuine dummy eTMA. Some comment that combining split TMAs and TMA00 would be confusing, particularly to new students or those not confident with ICT.

One tutor felt that, although pedagogically beneficial, split TMAs are messy to handle either on paper or electronically: ‘I believe the Mathematics department should ‘bite the bullet’ and deal with this properly. Split TMAs are there for pedagogical purposes, to give early feedback on the first TMA. However the paper TMA system was never altered to cater for split TMAs, i.e. the PT3 forms simply has one ‘date from student’ and one ‘date to centre’. So tutors manually deal with the situation by holding on to the PT3 form, posting the first part back to the student, etc. Now as the eTMA system naturally doesn’t cater for split TMAs, we are considering using TMA00 as a ‘work-around’. Also the TMA00 is, as the question implies, there to enable students to do a ‘dummy run’, and this is a useful facility for those students who use it. If we assume we do not want to get rid of the split TMAs (for pedagogical reasons), then the solution is either to change the eTMA system to cater for split TMAs (probably difficult and affects everyone), or else change the systems so that part 1 of TMA01 becomes TMA01, and part 2 becomes TMA02, and so on, with corresponding weightings given. Of course this still has a big impact, the assessments and weighting change, all the documentation changes, the assessment calculator changes, and so on. (I believe for any current course all TMAs are equally weighted, which makes things simpler … although some of the final TMAs are also ECAs). I can see no easy solution to the split-TMA problem but not solving it now will cause problems later.’

Technical issues

The numbers and main categories of queries and comments received from tutors are summarised in the following table. From April onwards, tutors were asked to supply a regular report on their marking experiences after each batch of eTMAs. Thus, from April, the data is split into solicited
feedback received from regular reports [RR], and unsolicited feedback collected from the tutor conference (and from emails direct to the MOL team) [OC].

<table>
<thead>
<tr>
<th>Issue</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Sep</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>eTMA system</td>
<td>2</td>
<td>12</td>
<td>9</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Hardware &amp; software</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>7</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>e-marking &amp; Word 2007</td>
<td>1</td>
<td>12</td>
<td>6</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Marking tools</td>
<td>0</td>
<td>1</td>
<td>13</td>
<td>12</td>
<td>10</td>
<td>9</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Converting documents</td>
<td>0</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>TOTALS</td>
<td>7</td>
<td>40</td>
<td>40</td>
<td>39</td>
<td>26</td>
<td>20</td>
<td>9</td>
<td>7</td>
<td>12</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

The main issues raised, most of which are alluded to elsewhere in this report, are as follows (further detail is given in Appendix A). The count of times mentioned is also given, noting that in some cases an issue was raised by the same tutor on more than one occasion.

**eTMA system**
- Problems downloading [6]
- Sent wrong files or omitted files when returning [10]
- How to replace incorrect files returned [6]

**Hardware and software**
- Word 2007 crashing / running slow [12]
- Difficulty inking with Wacom tablet and / or inking software [9]

**e-marking and use of Word 2007**
- Working with embedded images [7]
- Problems during or with inking [14]
- Math type symbols disappeared [6]

**Marking tools**
- Positioning of ticks and boxes [24]
- Marking ribbon difficult to install or disappearing [11]
- Marking tools too slow [5]

**Converting documents**
- Symbols missing in Word 2007 (cf Math Type issue above) [6]
- File size / quality of PDFs from Word 2007 [7]

**File sizes**
A significant number of the few students who contacted MOL directly reported problems with file sizes. The issue was mainly how to reduce the file size, particularly when using scanned or inserted images, prior to submission (see also the section on students’ perspectives).

In general file sizes were manageable for tutors in terms of down- and up-loading files. However, a few problems were reported, particularly with respect to conversion to PDF of files containing embedded images: ‘I was surprised at the large size of the files I was returning. I return one etma to the system at a time, as it is quite slow’. Even a modest 150 kb Word file explodes into a 2Mb PDF file when saved as PDF.’ ‘I was surprised to find the word version produced a file over 3 times the size on the cutepdf version.’ [Data on the sizes of files as they are returned by tutors was collected by AACS, and is reported in the section on Processing of maths eTMAs.]
Training and support

Comments from tutors were appreciative of the training provided, particularly the effort which the MOL team put into the guides and training sessions. However specific comments suggested that the guides and the conference were not as effective as had been hoped. The effort of providing them was appreciated, but the materials produced weren’t greatly used, at least not once the eTMAs started rolling in. One tutor commented that commencing the training earlier would have helped.

The online training sessions were judged more helpful than the guides. Face-to-face training sessions would be preferred by some: ‘I had a very good face to face session in R04 but this was not course specific – so didn’t deal with Word 2007. However it meant that I felt very good about the eTMA system in general. I’d have liked a day’s hands-on face to face workshop on Word 2007.’ Some tutors weren’t clear about the support provided by Regions on how to work with eTMAs.

Documents

The various guides were generally used in two ways: some tutors read them initially, whereas others preferred to use them as reference documents. ‘Thank you for the various guides and training sessions; there has been a great amount to absorb in a short time, and it is good to know that support is available when needed.’

Three tutors expressed feelings of being ‘dumped in it’ or isolated. All these also reported that they hadn’t read or made use of the guides. In some cases this was due to lack of time: ‘At the beginning I felt that I was bombarded with information and could not take it all in. Once the actual TMAs came in I had little time to revisit the guides as it took me so long to mark the eTMAs. With my other commitments I feel I have not had enough time to get up to speed with some of the tools and this means I probably don’t mark as quickly as I could. It would have helped to start earlier when there are no other course commitments but I understand why this was not possible.’ For others there were too many documents to look at: ‘It could be sent to me as hard copy. There are so many associated documents, some more important than others, that I have only printed off some of it, and seldom refer to it now.’

The ‘Guide on how to use Word 2007 for marking maths eTMAs’ was generally rated as useful, although some specific comments suggest otherwise.

- ‘Having a tablet laptop meant I was able to just get on with it without reading the guide!’
- ‘I haven’t looked at it recently. It was helpful originally!’
- ‘I’m afraid I couldn’t find that much that helped me – I got very confused with the basics such as having two layers to a textbox and that sort of thing slowed me down. I probably needed a dummies guide to Word 2007 in general, although I didn’t work through the online help tutorial. Somehow the structure of the Guide seemed a little unclear to me – I’m afraid I’m being vague as I now realise I’ve lost it, which probably says something too. Apart from learning how to save textboxes, and I seem to remember the Guide didn’t quite help enough there, I don’t think I’ve used it much.’

The ‘Quick Guide to using Word 2007 for maths eTMAs’ was probably issued slightly too late, as the evidence suggests that tutors had already started to develop their own approach, possibly based on what they had seen in the online training sessions or read in the more detailed guide.

The ‘Supplement to the guide to the eTMA system’ was also generally found useful. Only one tutor found it of little use, stating that they would have preferred a hard copy. It wasn’t used by tutors already familiar with the eTMA system and, inevitably, some would have preferred it to be integrated with the standard tutor guide to the eTMA system: ‘It would be helpful to have just one guide. Early on I had to annotate the ordinary guide with references to the Supplement, to ensure I did not go down the wrong track!’ ‘Perhaps it could include replacements for whole sections of the guide, to reduce the need for so much moving from one to the other.’
The ‘Guide to installing and using the MOL marking tools’ had a more mixed response. However comments on this are few and indicate that several tutors didn’t really engage with the marking tools. Some tutors reported that installation of the marking tools worked fine; others indicated problems (especially reported in the online tutor conference).

Online training sessions

Overall, the two online (Elluminate) synchronous training sessions were rated more highly than the other forms of support, with mean scores (out of 5): online session 4.35; documentation 3.95; (standard) eTMA training 3.78, MOL marking tools 3.4, online conference 3.82. All but two of the tutors rated online sessions as useful or very useful: ‘The Elluminate session were the most useful and valuable part of the whole training. Once I’d seen a demonstration of what was available and possible then I was confident that I could work out (or find out from the documentation) exactly how to do it myself – adapting it to my personal style and preferences. I’m not a computer whizz-kid or a geek, I’m simply a user who wants to know what the software can do and then use the bits which seem worthwhile for the job in hand.’

Main points made about the sessions were as follows.

- Main benefit of the sessions was to see the marking tools used: ‘It’s very difficult to follow descriptions of mouse movements and clicks, so seeing them in action is extremely useful.’
- Some tutors would have liked a summary rather than a complete recording. (The recordings of the sessions were made available to the tutors after each event.)
- Several tutors would have preferred the chance to try the tools before the online session.
- Smaller groups (perhaps determined by level of confidence) would be preferable.

Some tutors mentioned that they had problems with Elluminate (especially with the audio and the connection), and would have liked a separate introduction to its use first.

One possibility for training is that tutors first watch (online) recorded sessions which demonstrate how to undertake specific activities (e.g. using the eTMA system, Word 2007 for maths eTMAs, inking annotations, marking tools), and then invited to participate in online or face-to-face sessions for follow-up queries. Accompanying documentation would provide detail for reference purposes.

Online conference

There were mixed responses, with 14 tutors rating the conference as useful or very useful, but 8 rating it as not really useful. This may be because there were different expectations of the conference. Some wanted a general conference to share experiences, problems and best practice: ‘I thought there would be a more active participation, with different tutors answering each other, rather than just being a place where tutors asked for responses from the people running the trial. However I don’t know how people could be encouraged to post more, as perhaps the participants simply do not need to pose or ask questions. I would certainly be interested in hearing more stories of how other tutors are working with eTMAs (i.e. sharing best practice).’ Others were looking for a repository of definitive answers from those running the trial: ‘Not all requests for help on the MOL-eTMA-trial conference seem to be responded to by an MOL team member, but the majority are.’

As is often the case with asynchronous conferences categorising and organising information was problematic and, consequently, some found it difficult to find what they were looking for: ‘We have so many sub-folders, and in some of them I can’t even access the documents described. In the end, I’ve more or less given up looking.’

Overall perceptions

Since the trial was set up as a longitudinal study of tutors’ reactions to the introduction of e-marking in mathematics, it is important to reflect on their experiences at each of the three key stages.
Stage 1
In the initial stages of the trial, most tutors experimented with the various tools available, including the marking tools developed by MOL. A few tutors very quickly seemed to settle exclusively on either the inking or Word 2007 approach. All but one of the tutors reported a significant increase in time over paper marking, presumably due to a combination of the learning curve associated with handling and marking eTMAs, being novice users of Word 2007 and/or inking (and the associated hardware) and experimentation with different approaches to achieve the desired results. But most of the tutors already had the view that e-marking would take longer than paper-marking, especially where comments and notation are typed. Some tutors also spent time trying to use the MOL marking tools. However, these were not used as extensively as hoped, possibly because tutors had already started experimenting with alternative methods before the first version of the tools was released. Initial problems with some of the tools, for example slowness in the mark addition tools and instability of the page manipulation tools, were reported on the online conference and dissuaded others from trying the tools.

Feedback from the first tutor survey on the initial training and support was mixed. Some tutors admitted to not having read the documentation; and one or two others commented that they were thrown in at the deep end. At best the guides are seen as reference documents and, in general, the tutors found the online live training sessions much more useful.

Stage 2
As expected, tutors were having fewer problems with handling eTMAs, although some still found the processes to be cumbersome and unintuitive. Most were settling into an individual approach to marking which enabled them to maintain their quality of feedback. However, very few were reporting that their method was time efficient, and time considerations may be one reason why there were low levels of further experimentation. There were the first indications that some tutors were finding it necessary to consider modifying their feedback and annotations, but with allied concerns that these may result in lower quality ‘correspondence’ tuition and less personalisation.

Stage 3
Generally, tutors had not significantly changed their approach, preferring to make their chosen method as efficient as possible, though there was less use of the MOL tools. Tutors were more likely to recycle comments or solutions, even though the desire to personalise them and follow through from the student’s solution negated some of the benefits. Overall tutors expended considerable effort to replicate the quality of their work on paper TMAs; however it was apparent this effort was unsustainable in the long run. Concerns were voiced over reduction of personalisation of feedback.

In the final survey, tutors were asked to say what they felt were their three most positive aspects and three most negative aspects of maths eTMAs. These have been categorised as follows.

### Positive aspects

<table>
<thead>
<tr>
<th>Comment</th>
<th>Instances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easier and quicker document handling (avoids post)</td>
<td>18</td>
</tr>
<tr>
<td>Re-use of comments, solutions, diagrams</td>
<td>10</td>
</tr>
<tr>
<td>Better comments (legibility, fuller)</td>
<td>6</td>
</tr>
<tr>
<td>Ease of correcting / tailoring comments</td>
<td>6</td>
</tr>
<tr>
<td>Potential for better / quicker service to students</td>
<td>3</td>
</tr>
<tr>
<td>Reassurance for student / tutor that it has arrived</td>
<td>2</td>
</tr>
<tr>
<td>Makes marking more convenient</td>
<td>2</td>
</tr>
<tr>
<td>Learned to use Word 2007</td>
<td>1</td>
</tr>
<tr>
<td>Marks automatically totalled</td>
<td>1</td>
</tr>
<tr>
<td>Better standard of document from student</td>
<td>1</td>
</tr>
</tbody>
</table>
**Negative aspects**

<table>
<thead>
<tr>
<th>Comment</th>
<th>Instances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to mark</td>
<td>13</td>
</tr>
<tr>
<td>Can’t mark at odd moments / places: tied to PC</td>
<td>6</td>
</tr>
<tr>
<td>Inserting /positioning ticks, textboxes etc</td>
<td>5</td>
</tr>
<tr>
<td>Word 2007 including maths facilities</td>
<td>5</td>
</tr>
<tr>
<td>Embedded images</td>
<td>4</td>
</tr>
<tr>
<td>Not a great take up by students</td>
<td>4</td>
</tr>
<tr>
<td>Stressful / more tiring (H&amp;S)</td>
<td>4</td>
</tr>
<tr>
<td>Frustrations with technology</td>
<td>4</td>
</tr>
<tr>
<td>Difficulties with diagrams</td>
<td>3</td>
</tr>
<tr>
<td>Lack of space to insert comments</td>
<td>2</td>
</tr>
<tr>
<td>Dealing with file formats (including Mathcad)</td>
<td>2</td>
</tr>
<tr>
<td>Reliance on computers, connections and computer systems</td>
<td>2</td>
</tr>
<tr>
<td>Reminder emails from eTMA system</td>
<td>1</td>
</tr>
<tr>
<td>Not best use of students’ time</td>
<td>1</td>
</tr>
<tr>
<td>Finding way around a long document</td>
<td>1</td>
</tr>
<tr>
<td>Having to insert marks manually</td>
<td>1</td>
</tr>
<tr>
<td>eTMA system</td>
<td>1</td>
</tr>
<tr>
<td>Difficult to mark across a number of scripts</td>
<td>1</td>
</tr>
<tr>
<td>Small tablet inadequate</td>
<td>1</td>
</tr>
<tr>
<td>Inking not working well</td>
<td>1</td>
</tr>
<tr>
<td>Changing approach for different eTMAs</td>
<td>1</td>
</tr>
</tbody>
</table>

Tutors were also asked what they would do differently if they were to continue to mark eTMAs in subsequent presentations of their course(s). The responses suggested that changes wouldn’t be dramatic (unless they had different equipment), but that they would continue to try to improve their current methods.

- ‘I would be more methodical in preparing commentary for common mistakes or areas of poor understanding and have these ready for insertion where appropriate.’
- ‘I would also train myself to use the drawing facilities within Word.’
- ‘At the moment, I would expect to do the commenting in the same way as I do now. Is, use textboxes for embedded images, and simply type into word documents.’
- ‘I would only use a tablet and inking. I would try and mimic paper TMA marking as much as possible.’

Some took the opportunity to mention the potential helpfulness of electronic tutor notes.

- ‘It would have been very useful to have the tutor notes online.’
- ‘The mark scheme used by tutors is available in a PDF format, but it does not really have comments that can be snapped into the eTMA document, and if eTMAs were universally used, then I think that the course team should consider designing the mark scheme to incorporate comments that could be snapped in.’

None of the tutors mentioned the desire to have a repository of comments and solutions shared amongst tutors (although this was not explicitly asked); however, any such facility would have to be very quick and straightforward to access and provide annotations which could easily be modified to outweigh creating one’s own repository of preferred annotations.

In summary, if maths eTMAs are to be rolled out more widely, the major aspects which need to be addressed are:

- Provision of appropriate hardware and software. ‘I would only use a tablet and inking. I would try and mimic paper TMA marking as much as possible.’ ‘Getting a new monitor
which is wide enough for two pages side by side has helped especially for solutions which don’t fit on a single page – this is a recommendation for tutors thinking of new PCs’

- Time taken at all stages of the process: ‘If my workload would really be doubled (or at least significantly increased) with real eTMAs who will pay for that? Whatever time my student saved by sending the TMA electronically has been spent many times over by me trying to type out things that would take seconds by hand. It might suit the students but certainly doesn’t suit me. And, as he didn’t get me at my best so ultimately it won’t suit him either.’

- Ability to accurately place textboxes. ‘I would like a tried and tested Marking Tool Ribbon that would reduce the time to mark (we might already have this, but the placing of textboxes where you want them seems a paramount consideration).’

- Availability of tutor notes: ‘Can tutor notes be produced and made available to tutors in Word 2007 format?’ ‘Marking eTMAs would be easier than paper ones if the tutor notes were available online to use for giving the students part or full worked answers (especially for weaker students).’ ‘I have now mastered (ish) the snapshot tool from Adobe and found that very useful for adding in snippets from the specimen solutions – that’s very handy.’ ‘I very much like being able to take snapshots of appropriate parts of my scanned solutions (in PDF format) and inserting them at an appropriate part of the eTMA.’ ‘I would like ready prepared solutions sent electronically to tutors. These solutions would be designed so that different parts could be cut and pasted easily— they would not need and perhaps should not have the marks inserted. For this copying and pasting to be allowed— perhaps I have missed some important directive, but I believe tutors [on my course] have never been given permission to photocopy model solutions from the mark scheme for students.’

- More streamlined processes. ‘When you are handling TMA’s you have to have two additional windows open, and this can cause other windows to be stacked, making it more involved to get to what you want. It seems particularly slow at responding to the command ‘return TMA’.’

- The PT3 form seems reasonably archaic. It could at least have a spellchecker.

- The word processing capabilities on the PT3 form for eTMAs seems to be very limited, which is a pity.

- ‘Provision of training and support, and resource to enable tutors to engage with different hardware and / or software and approaches to marking.

- Rationalisation of the documentation for tutors and for students.

Tutors’ opinions were split as to the best way for students to prepare their work though, undoubtedly, the tutors were seeking uniformity in the document formats they would receive. Some felt strongly that students should handwrite and scan their work for submission, so that they don’t have the additional burden of typesetting. Others, probably assuming that they would be marking in Word 2007, wanted all students to use Word to prepare their assignment work: ‘As things stand, I could not recommend transferring M208 to eTMA format. The tools are not there to do the marking job properly, and scanning in TMAs is time-consuming for the students, particularly given size constraints. All students could be persuaded to use Word 2007 and its native mathematical processing, things would be completely different, and I would recommend use of eTMAs.’
A couple of more extensive comments sum up the experiences of many of the trial tutors.

- ‘I know that I am slower and find eTMAs less convenient because I am so used to paper marking. I could do with typing quicker as this would help with the PT3 part. I have spent a lot of time sorting out what works for me and what I am happy with when marking electronically and different tutors will prefer different tools. I still need to work on the input of mathematical language and a resource of ready worked answers would help. I can see myself getting more and more used to eTMAs, but I cannot imagine being quicker than with TMAs unless what is available to tutors to provide feedback is much improved.’

- I did like marking with the eTMA system, and I particularly liked to be able to copy handwritten comments and diagrams that I had scanned into a PDF document into relevant places on the student’s scripts. Scripts that had been prepared in Word seemed to be quicker to mark, and in these I particularly liked the fact that I could insert comments very easily within the work, and make space at good points within the work if this was not done by the student. With scanned image scripts I liked the fact that I could insert a blank page wherever I wanted to.

I also liked the possibility of “recycling” comments, with adjustments for each student, but the only disappointment with this was that I never had more than 4 or 5 eTMA scripts for any particular assignment, so I did not exploit this facility, by saving many comments in the gallery: with more scripts I would take the trouble to do this, and I think that it would pay off.

Another great feature was that I could very easily remove comments or change them if I changed my mind about a comment, or if I wanted to change the comment from what I had written earlier.

The mark scheme used by tutors is available in a PDF format, but it does not really have comments that can be snapped into the eTMA document, and if eTMAs were universally used, then I think that the course team should consider designing the mark scheme to incorporate comments that could be snapped in.

My biggest frustrations were:

1. Every time I wanted to insert a textbox or callout it went in at the top of the page, and then it was a real pain to drag it to where I wanted it to be – I do not see why textboxes should not go in at the cursor, to eliminate this frustration. Some effort and time should go into developing this improvement, if eTMAs are used universally for Maths. On the email conference it has been suggested that this may be a feature of the way that images are placed on pages in the document (in scanned image documents), and that if images were placed differently on the page (say, over a page full of carriage returns) then it may be possible to get the textbox where you want it immediately.

2. I like to write comments in also, but the Wacom tablet supplied was inadequate for this due to its small size – it was so difficult to get good legible handwriting into a document, and the control I had was not as good as I wanted, so I sometimes had to cut and then replace comments. I use a larger tablet at the college where I work for putting comments onto a whiteboard for a data projector (and inserting comments onto Smartboard Notepad document) and the control I have with that is much better. I think that having a Tablet Laptop, where we could write directly into the document in real size would be really good, and far superior to annotating paper marked documents – but Tablet Laptops are expensive (I think that we should still strive for them though).

3. I liked to use the Meanders Inking Tool, and this worked quite well, but I found that I could never get the exact thickness of the writing that I wanted – in the end I opted for slightly thicker than I wanted, as this looked better than the wiry looking slightly thinner. A frustration when using the inking tool was that a palette in Word kept appearing where I was writing (it seemed to be anticipating that I would want to use it), and I never found out how to turn that facility off. It was slightly annoying that make two clicks of the pen when I wanted to start inking and then click to turn inking off when I wanted to type, or use a
when writing manual scripts, I just write, so this clicking adds to the time, because I like to have a good mix of written comments and comments within textboxes.

(4) I liked the idea of using the Mark Insertion Tool that the MOL team produced, but when I tried it, it took an increasing length of time to insert the individual marks as I progressed through the document, so I just put marks in by hand using the inking tool.

In summary: ‘The OU currently has the same recommended PC spec for Als and students, and this won’t do for marking maths eTMAs, and I think additional financial help will be needed. My old machine was more than adequate for M263 software and for marking eTMAs, but not for this work.’

Some tutors recognised that eTMAs are the way to go, and even had positive comments:

- ‘My first experience of marking eTMAs was less traumatic and more satisfying than I think I had expected, and some of the students have expressed satisfaction with the format of my comments.’
- ‘I would like it to become the norm (but let’s get the tools working properly first).’
- ‘Despite the considerable extra work I have enjoyed the challenge of electronic marking – and I have experienced fewer problems than I think I anticipated.’

And some felt the process overall wasn’t too bad: ‘I am enjoying marking electronically.’ ‘I have enjoyed the challenge but am thankful that only three students have submitted electronically as it is very time consuming.’ ‘I quite enjoy marking them, really.’

Others are yet to be convinced: ‘I will not voluntarily do it again!’

The students’ perspective

The following sections are based on feedback from the student survey, which a total of 181 students completed, giving a response rate of just over 30%. Of these, 97 (53.6%) didn’t submit any maths eTMAs, and 84 (46.4%) had submitted one or more. The 84 represents 40.6% of all the students who submitted one or more eTMAs during the trial.

Students who didn’t submit any maths eTMAs

Of the students who hadn’t submitted any maths eTMAs about 40% said they would be likely to do so if offered the opportunity on a future maths course. Eighty students gave a reason as to why they hadn’t submitted any maths eTMAs when given the chance, as follows.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number</th>
<th>Typical comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not aware the option was available</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Tried to use web submission</td>
<td>3</td>
<td>Includes trying to use the main eTMA system directly</td>
</tr>
<tr>
<td>Computer / internet problems</td>
<td>4</td>
<td>Limited internet access. Upgrade to Vista</td>
</tr>
<tr>
<td>Technical difficulty of typesetting mathematical</td>
<td>7</td>
<td>Don’t have suitable software</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Don’t know how to use suitable software</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Concerned about resulting file size</td>
</tr>
<tr>
<td>Submission on paper more convenient / quicker</td>
<td>14</td>
<td>Process seemed complicated or time-consuming to get to grips with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Don’t like using computers</td>
</tr>
<tr>
<td>Inconvenience of typesetting mathematical notation / not preferable pedagogically</td>
<td>23</td>
<td>Slow to do</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Handwriting helps learning, is easier to check, better preparation for the exam [4]</td>
</tr>
<tr>
<td>Scanning not feasible</td>
<td>9</td>
<td>No scanner available (for some combined with preference to handwrite)</td>
</tr>
</tbody>
</table>
Scanning didn’t produce acceptable results | 4 | Over-sized files
---|---|---
Other | 8 | Not enough time to learn how to do it
| | Not enough training
| | Not sure of reliability of system
| | Not interested

Likelihood of submitting maths eTMAs on future courses (percentage of 79 question respondents)

Students who submitted one or more maths eTMAs

Of the students responding who did participate in the trial, 59.1% had never previously submitted eTMAs (i.e. on non-maths courses). Just over 20% had submitted eTMAs on one other course, and just over 10% on more than three other courses.

eTMA preparation

Students were asked about how they prepared their work prior to electronic submission, and how straightforward they found it to do so. About a third of students scanned their handwritten work, with half then submitting image files and half converting the output to PDF. Nearly 30% used Word 2007, but only about two-thirds of these actually submitted a Word 2007 document, suggesting that the remainder were converted to PDF or to Word 2003 before submission. This concurs with the fact that slightly fewer students used Word 2007 to produce their mathematical notation, with MathType being a popular alternative. There is anecdotal evidence that some students with access to Word 2007, either weren’t aware of its mathematical features or chose not to use them, perhaps preferring to stick with a facility with which they were already familiar.

Nearly 50% of students produced any required diagrams by hand. Surprisingly nearly 20% produced diagrams from Excel, although use of the package is not prescribed, or encouraged, on any of the courses in the trial.

Most students found their chosen method(s) of TMA preparation to be straightforward, though slightly less so for mathematical notation, and less so again for diagrams.
Main method of preparing eTMAs

- Handwritten: 31.0%
- Word 2007: 28.6%
- Previous Word: 22.6%
- LaTeX: 10.7%
- Open/Star Office: 4.8%
- Other: 2.4%

Other: MS Journal on a Tablet PC saved as PDF

How straightforward was your chosen method?

- Not at all
- Not very
- Fairly
- Very

Bar chart showing the distribution of responses:
- Not at all: 0.0%
- Not very: 10.0%
- Fairly: 31.0%
- Very: 60.0%
Main method of producing mathematical notation

Other: ASCII Math, MathCast (open source equation editor), Open Office Math, MS Journal on a Tablet PC saved as PDF.

How straightforward was your chosen method?
Main method of producing diagrams (if required)

![Diagram showing the methods of producing diagrams](image)

- Excel 19.8%
- Drawn within Office 2007 7.4%
- Drawn within previous Word 6.2%
- Other drawing package 9.9%
- Other 8.6%
- Hand-drawn 48.2%

Other drawing package: Adobe illustrator, Open Office, Geometer’s sketchpad, Maple, Paint shop, PowerPoint
Other: Minitab, Maple, Mathcad, Mathematica, Gnuplot, MS Journal, course software.

How straightforward was your chosen method?

![Bar chart showing the responses](image)

Students were asked a number of questions about how preparing TMAs for electronic submission differed from preparation of TMAs for postal submission. Overall, just below three-quarters said that, their preparation process was not at all different or not very different to how they would prepare paper TMAs: only just over 10% found it to be very different. Those typesetting their eTMAs, and particularly those using Word 2007, were more likely to indicate that their method of preparation had changed for eTMAs.
The following graphs show that, for some, the preparation of TMAs for electronic submission did take longer. However, this was as likely to be for those handwriting (and hence scanning) their work, as it was for those typesetting it.

**How preparation time for eTMAs compares to that for paper submission**

The graphs show the distribution of respondents' perceptions of how the preparation method differed for eTMAs from paper TMAs.
How preparation time for different preparation methods compared with time for paper TMAs (number of respondents)

A good proportion of students took advantage of the facility to submit later.

How far in advance of the cut-off date eTMAs were submitted

How time of submission compared to postal submission

Comments made by students about the preparation of their maths eTMAs were varied, and a selection of the observations made is included here.
<table>
<thead>
<tr>
<th>Positives</th>
<th>Interesting / typical comments</th>
</tr>
</thead>
</table>
| **Benefits of eTMAs** | • I liked the fact that I get additional time for submitting TMAs if I use the eTMA system. I have to allow at least 5 days for sending the TMAs by mail, so I have 5 additional days...
• Comparing this system with postal submission, I have always considered it poor that, until receipt of a marked TMA, there is no way of knowing, if the TMA has arrived with the tutor; this method of submission cures this shortfall, so I hope it will become available for other Maths courses.
• eTMAs were ideal for someone who is abroad as it meant that I knew that I had met my deadlines without having problems with post.
• The eTMA system is very convenient: I travel regularly and didn’t have to worry about finding Post Offices or the time sent to post from abroad.
• It is safer than relying on the post.
• I really like the idea, it may take slightly longer but it does cut out slogging up to post office (for proof of postage). I also found that because MathCast is so easy to use I ended up using it as part of the “thinking process”, not just as a finishing tool. In the end I did everything (almost) is MathCast and just pasted the images into Word. Word was relegated to the role of a receptacle!
• It very much helped with clashes between my courses, where TMAs were due in the same week this gave me more time to spread the load.
• Much easier to make corrections and store different versions of the eTMAs and mathematical notation. |
| **Additional work, or not** | • As we are advised to photocopy our normal TMAs before submission, it is just as easy, if not easier, just to scan them in.
• I prepare a paper TMA by scanning in handwritten work anyway, so the only difference with the eTMA is that I PDF the document before sending.
• I hand write my assignments. I scan them so that I have a copy just in case the TMA gets lost in the post! So sending the eTMA is just a simple matter of adding the scanned file to an email. |
| **Handwriting versus typesetting** | • I handwrite Maths because I find this integral to the thinking process for Maths. I do not have enough experience with Maths software to know whether I would eventually be as fluent as when handwriting but I suspect not. I would be extremely unhappy if the regulations said I had to produce the Maths in a word processed format. The only extra time taken with submitting is scanning, which takes longer than copying but is worth it as I now have an electronic record of my work. |
| **Word 2007** | • I did not have Word 2007 for my first eTMA submission and used Word 2003 with MathType. A lot easier with 2007. Having a cheap version of Word 2007 available was an incentive to get it.
• I have been very pleased with the output I have produced using Word. One of the reasons for using it was to improve the presentation of my work and that has been achieved. There was an initial learning curve with the maths facilities of Word and the quirks with formatting but after several TMAs it is not a problem.
• I purchased MS Office 2007 because I’d heard that handling equations was far better than with the older Equation Editor. It is. As accredited students can obtain significant discounts on software, I would urge the OU to “push harder” in this direction.
• I have had a brief look at the maths facility in Word 2007 and in true Microsoft tradition it’s just too involved. |
• There is a learning-curve associated with using eTMA – file formats, and new use of WORD 2007. But once familiar with these it is a v straight-forward process. And the response times have been superb.

LaTeX

• I like LaTeX and always use it anyway.
• I would use LaTeX to type my TMA anyway, so the only drawback of electronic transmission is the need to produce digital pictures and graphs (using software or scanning drawings) – but that is also a useful learning experience and the other advantages of eTMAs are (for me) overwhelming.

Scanning

• Most TMAs were handwritten, then scanned as .tif files using MS Office (2003) Document Scanning. Multiple pages were scanned into one .tif file (although I did break the tma into 3 or 4 .tifs incase I had to rescan). The .TIFS were then printed as PDFs using CutePDF (free sw). The multiple PDFs were then combined using PDFill (free PDF Tools), and a header inserted. The scanning and combining process would normally take less than 30 minutes. However, for posted TMAs I would normally photocopy, (or scan if at home) so there isn’t much difference in time to prepare.
• I would probably use a different preparation method if I had time to get used to it (either try Word 2007 again or learn to use LaTeX), but hand writing and then scanning to PDF worked well.

Negatives

Interesting / typical comments

Technical / processing / file size

• I didn’t use the TMA00 facility as I have done eTMAs before – however the maths eTMAs was a different route, which tripped me up when it came to submit. One problem some of my peers had was getting their submission below 2Mb or 3Mb (I can’t remember the limit for this course) and TMA00 would not test those skills. Some guidance on minimising file sizes would be useful – e.g. techniques for minimising scanned image size, techniques for cropping/compressing images etc. I’ve become quite adept at using Word to minimise the file size, but not all students are so computer literate. Also, on one eTMA, I accidentally deleted a page immediately prior to submission and although I submitted the missing page as soon as I was notified, they would not.
• I would have submitted more eTMAs but the size of the scanned files are typically larger than permitted. But for this, it would have been my preferred method. Also, I would have used a suitable software package except for the additional expense of purchase – I have Word 2002.
• The course (MS325) uses Maple extensively. Some of the TMA questions did not take into account the restrictions (on file size) of the eTMA system.

Typesetting

• The only annoyance is typing in formulas, which takes up most of the additional time.
• Would take too long to do by computer, rather than handwritten.
• I submitted the first assignment using eTMA as it was mainly words and graphs which I could do easily using Microsoft word and copying graphs from Minitab. For the following assignments I was not prepared to try eTMA because there was a lot more mathematical notation and I did not feel that I had the time to figure out how to reproduce that in type. If I had a scanner I would have probably scanned my written script and sent it using eTMA as it gives an extra day or two preparation time.
• I discovered equation editor after submission of my second TMA and this helped in formulating equations but the process was very time consuming.
• My personal view is that I’ll never be able to word process maths.
• Typing equations takes forever! A great deal of effort was needed to check
for typos, etc. The one upside was that I occasionally spotted a maths error – and then of course it could be corrected more easily. However, overall I estimate total TMA prep time was up 200-400% vs handwritten.

- While straightforward, constructing formulae in Word 2007 can be a bit time consuming. Copy/Paste can speed things up. I used a combination of Minitab and Excel for calculations [did the student mean to say ‘graphs’?].
- Most of my TMAs were done with word2007 and Mathtype. My last TMA is being done using Latex. After the initial learning curve latex is probably just as easy as word, and gives a better result than word. I tried using the word 2007 math features but didn’t find them easy to use (compared to Mathtype) and I didn’t like the result as much.

<table>
<thead>
<tr>
<th>LaTeX</th>
</tr>
</thead>
</table>
| • I would have liked to use LaTeX for this, as the scanning of notes was a hassle, but I didn’t have time to learn it. It would have helped if there was a “Learn LaTeX as you go” process that ran alongside the course, like the MathCad exercises.  
• I would have prepared differently if I had Word 2007. Latex seemed too time consuming so I wrote by hand and scanned. |

<table>
<thead>
<tr>
<th>Scanning</th>
</tr>
</thead>
</table>
| • I did not like having to make one image per page.  
• Scanning was not an option (due to low quality) so I used word 2007.  
• The hand preparation was the same, then I had to scan it into the computer and generate a word document. This is where the extra time was required and I would say it too an extra hour to perform this process.  
• The only problem was getting scans to produce the required file size within A4 dimensions. I had some advice in preparing my first eTMA and no problems thereafter. |

### eTMA submission

The vast majority of students said that they found the process of submitting maths eTMAs to be fairly or very straightforward; with less than 10% indicating they had any significant difficulties. The ratings were very similar for handwritten work and for typeset work. Students were asked how the maths eTMA submission process could be improved, with the following results.

<table>
<thead>
<tr>
<th>Improvement</th>
<th>Number</th>
<th>Interesting / typical comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nothing!</td>
<td>13</td>
<td>• I can’t think of any improvements – the system was excellent.</td>
</tr>
<tr>
<td>Clearer instructions</td>
<td>5</td>
<td>• Publishing a pictorial booklet and sending it to the students who are interested in the process.</td>
</tr>
</tbody>
</table>
| Easier typesetting of maths | 3 | • OU to provide a fairly powerful and easy to use equation editor – but in general Word Equation Editor is good enough.  
• One software for math equation, graphs and text. |
| Direct submission to the main eTMA system | 9 | • If the existing eTMA system could cope with the submission then it would be ideal as it is what people on other courses would be used to, though submitting by email is fairly straightforward as long as the subject line is entered correctly.  
• It would be easier if it could be linked to the eTMA system online so I can access it where ever I am as I cannot access my email at work so I was sending eTMAs from different locations and not always getting them through due to format differences etc...  
• Using the main web-based submission route rather than the email route – where you can save previous versions until the submission deadline. |
Web submission (preferably from StudentHome), so don’t need emails with subject in very particular format

9

- Web submission would be much easier. The detail required in the email header and massive delay in feedback made it difficult.
- The student could use an upload facility available on their homepage. This would get around any mistakes made when trying to use the correct identifier/code etc in the subject line.
- Possibly an option to submit the TMAs via StudentHome site might be simpler? Ideally this would be more interactive, allowing you to see immediately whether the document passed each stage in the system.
- Less reliance on emails with particular subject lines, and perhaps a simpler web interface.

Facility to check processed documents before actual submission

1

- A facility to check that a submission would be accepted, and would be acceptable quality is needed. Submitting a TMA, and then hoping that the conversion process will work, and that the results will be acceptable, is not a good process. Particularly so if access to email (eg, at work) is restricted. It would have been a lot better if I could have sent a test submission, and then been able to see the results BEFORE the actual submission.

Larger file sizes

8

- Even with plain paper and scan settings of Grey scale, 200 dpi, Jpeg then Zip, 3 MB is only good for about 20 sides max. Those who can’t tweak their scanning software haven’t got a hope!
- The actual submission is straightforward however getting a file the correct size limit can be frustrating and time consuming.

Other

5

- I’m on Windows ME and therefore could not give my TMAs the final check before sending. Why don’t you support older operating systems.
- Made available on all maths courses.
- I would say that one return mail to indicate (final) success or one at point of failure, with the reason.

With regard to the test eTMA (TMA00), all of the respondents had taken the option to submit it, and only 6% didn’t find it either fairly or very useful to have the facility to do so.

Students who, at some stage, had chosen to stop submitting eTMAs, were asked why this was so. Only 13 students gave meaningful responses to this question, and these are summarised as follows.

**Those using Word**

- Lack of ability to type out mathematical notations.
- Lack of time to prepare eTMAs.
- Feedback on early eTMAs was quite terse, so the student felt that they were missing out on extra information that the tutor could have included but was restricted in doing so by the time taken to mark eTMAs.

**Those scanning handwritten work**

- Scanned file size was too large.
- Printer / scanner broke down.
- Could not get the scanned files to attach to email / own mailbox too full.
- Only submitted eTMAs whilst abroad.
- Didn’t need the extra time to do the assignment afforded by submitting electronically.

**General**

- Wasn’t sure if extensions could be handled on the eTMA system.
- Student thought that a TMA of 60 – 65 pages excessive for tutor to mark electronically.
- Withdrew from course / didn’t submit final TMA(s).

Students were invited to give further comments on the submission of maths eTMAs. Of the 24 meaningful responses, fifteen confirmed that they liked the system, and found it easy and convenient to use. Three students mentioned the file size restriction issue, and another three had concerns about non-receipt or delay in receipt in confirmation emails. The remaining three comments were about not liking the processing of files, the difficulty of typesetting mathematics, and the delay in receiving feedback on TMA00 before submitting the first summative TMA.

**eTMA return and feedback**

All the students who responded stated that their marked eTMAs had been returned to them either in a fairly or very acceptable timescale, and all but one felt that their eTMAs been returned in an acceptable format (i.e. which they could open and clearly see their original work and their tutor’s additions). When prompted, however, a few mentioned problems encountered in this respect.

- Mathematical notation didn’t always come through as expected.
- Tutor’s comments tended to disrupt document formatting, especially lines of maths.
- Concern about inadvertent deletions or amendments by the tutor.
- Not always possible to differentiate tutor’s comments from student work.
- Student had to open the document at work to be able to read it because their ‘home computer is rather dated’.
- Two students used Linux which made it difficult / impossible to view Word 2007 documents.
- Confusion over work coming back by email and being able to collect it (from eTMA system).

Nevertheless, one student took this as another opportunity to give positive feedback: ‘I am delighted with the system. ... The speed with and helpfulness with which both my tutor and her support addressed both issues was impressive.’

Students were asked about the quantity and quality of the comments and feedback they received.

<table>
<thead>
<tr>
<th>Did your tutor provide an appropriate quantity of comments on ...</th>
<th>Too few</th>
<th>Slightly too few</th>
<th>About right</th>
<th>Slightly too many</th>
<th>Too many</th>
</tr>
</thead>
<tbody>
<tr>
<td>... your maths eTMAs?</td>
<td>1.2%</td>
<td>4.7%</td>
<td>94.1%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>... the PT3 for your maths eTMAs</td>
<td>0%</td>
<td>1.2%</td>
<td>97.6%</td>
<td>0%</td>
<td>1.2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Were the following acceptable on your maths eTMAs ...</th>
<th>Not at all</th>
<th>Not very</th>
<th>Fairly</th>
<th>Very</th>
</tr>
</thead>
<tbody>
<tr>
<td>... legibility of tutor’s comments?</td>
<td>0%</td>
<td>0%</td>
<td>11.9%</td>
<td>88.1%</td>
</tr>
<tr>
<td>... clarity of tutor’s diagrams?</td>
<td>0%</td>
<td>0%</td>
<td>18.2%</td>
<td>81.8%</td>
</tr>
</tbody>
</table>

Only one student, when prompted, gave details of a particular problem: ‘I think my tutor had trouble with symbology and finding her feet in trying out different ways of differentiating her text from mine. I assume she was using Word 2007 to do the marking and this might have restricted her a little.’

<table>
<thead>
<tr>
<th>Did your tutor’s comments (including any diagrams) help ...</th>
<th>Not at all</th>
<th>Not very</th>
<th>Fairly</th>
<th>Very</th>
</tr>
</thead>
<tbody>
<tr>
<td>... you to understand errors?</td>
<td>0%</td>
<td>2.4%</td>
<td>26.2%</td>
<td>71.4%</td>
</tr>
<tr>
<td>... show you the correct approach?</td>
<td>0%</td>
<td>3.6%</td>
<td>26.5%</td>
<td>69.9%</td>
</tr>
<tr>
<td>... you improve your work?</td>
<td>0%</td>
<td>3.6%</td>
<td>45.8%</td>
<td>50.6%</td>
</tr>
</tbody>
</table>

All the students felt that their tutor’s comments were either fairly well or very well addressed to them personally. This question was specifically asked, because some tutors were concerned that typeset comments might more easily be interpreted as not being addressed or tailored to the individual student. Only one student commented on this aspect when asked how tutor’s comments...
could be improved: ‘somehow I find that I responded better to handwritten comments rather than typed. It may be that handwriting comments is quicker and therefore written comments are more extensive/comprehensive.’

The ratings given by students for these various quality aspects were looked at against their eTMA preparation method, as follows. All were on a 4-point scale, ranging from ‘not at all’ to ‘very’, except the ‘quantity of comments’ question which was on a 5-point scale from ‘too few’ to ‘too many’. The values represent weighted means of the responses within each category.

<table>
<thead>
<tr>
<th>eTMA preparation method</th>
<th>acceptable format</th>
<th>quantity of comments</th>
<th>legible</th>
<th>help to understand errors</th>
<th>show the correct approach</th>
<th>help improve work</th>
<th>comments personally addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of points on scale</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Word 2007</td>
<td>3.8</td>
<td>3.0</td>
<td>3.9</td>
<td>3.7</td>
<td>3.6</td>
<td>3.6</td>
<td>3.7</td>
</tr>
<tr>
<td>Previous Word</td>
<td>3.8</td>
<td>2.8</td>
<td>3.8</td>
<td>3.7</td>
<td>3.6</td>
<td>3.4</td>
<td>3.7</td>
</tr>
<tr>
<td>Weighted mean of above</td>
<td>3.8</td>
<td>2.9</td>
<td>3.9</td>
<td>3.7</td>
<td>3.6</td>
<td>3.5</td>
<td>3.7</td>
</tr>
<tr>
<td>Open or StarOffice</td>
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<td>3.0</td>
<td>4.0</td>
<td>3.8</td>
<td>3.8</td>
<td>3.3</td>
<td>3.8</td>
</tr>
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<td>3.8</td>
<td>3.0</td>
<td>3.9</td>
<td>3.9</td>
<td>3.9</td>
<td>3.4</td>
<td>3.8</td>
</tr>
<tr>
<td>Handwritten</td>
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<td>2.9</td>
<td>3.9</td>
<td>3.6</td>
<td>3.6</td>
<td>3.4</td>
<td>3.7</td>
</tr>
<tr>
<td>Weighted mean of above</td>
<td>3.8</td>
<td>2.9</td>
<td>3.9</td>
<td>3.7</td>
<td>3.7</td>
<td>3.4</td>
<td>3.8</td>
</tr>
<tr>
<td>Other</td>
<td>3.8</td>
<td>3.0</td>
<td>3.8</td>
<td>4.0</td>
<td>4.0</td>
<td>3.6</td>
<td>4.0</td>
</tr>
</tbody>
</table>

The preparation methods have been divided into two categories: those which were broadly speaking likely to give rise to editable Word documents for tutors, and those which were likely to result in embedded images. The table shows that there is no discernable difference in how students view the quantity and quality of tutor feedback for these two categories.

Students were invited to give further comments regarding the feedback they had received on the maths eTMAs. Twenty-one such comments were given, covering the following topics.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Number</th>
<th>Interesting or typical comments</th>
</tr>
</thead>
</table>
| Excellence of tutor feedback | 9      | About half explicitly mentioned legibility as a positive attribute.  
• It is a great system because I no longer having to try and decipher the handwriting of the tutor.                                                                                                                                                                                                                                                                                                                                                       |
| Timeliness of tutor feedback | 3      | • Excellent feedback. Most of my TMAs were returned within 24 hours of the deadline – this is great because if the time lag is too great it is difficult to remember what you were thinking when you wrote the work. This is particularly true when the TMA questions are answered as the particular block is studied. The fast feedback was very much appreciated, previously I have waited up to a month for feedback.  
• Very quick feedback, never longer than 2/3 days from cut-off.                                                                                                                                                                                                                                                                                                                                                           |
| PT3 form                     | 2      | • I prefer eTMA feedback since the written duplicate form fades and thus difficult to read some months later.  
• I would prefer to have the PT3 comments in the body of the email, rather than having to unzip a file etc. It would make it a bit simpler to read especially when using a mobile device.                                                                                                                                                                                                                                                                                  |
| Disruption of student’s work | 3      | • I can see that it’s more difficult to intermingle the comments with the text than with real paper.  
• I think something needs to be done regarding tutor’s comments disrupting the format/layout of the original document.  
• I was able to query a lost mark due to the tutor copying a section from another answer and removing the same mark twice.                                                                                                                                                                                                                                                                               |
• Some of the worked examples supplied were a little feint and had a smaller font than I am used to – I found some of them difficult to follow for this reason.
• My tutor did comment that it took longer to mark an eTMA than a hand written one.
• Streamline the process a bit. Either the tutor returns it or you collect it. Not both.
• Had to buy Office 2007 to participate: scanning handwritten docs blew file sizes and were not adequately reduced in size by zipping

Overall experiences
Students were asked to list their three most positive aspects, and three most negative aspects, of maths eTMAs.

Positives
Eighty students provided at least one positive aspect, giving 223 positive comments in total. Although most of these are reasons why students might prefer eTMAs regardless of the curriculum area, some of the comments were specifically related to studying maths.

• The method I used was also part of the thinking process.
• I found it straightforward to prepare using Word 2007 much prefer to do it & send electronically.
• It has developed my written maths presentation skills – and encouraged me to learn Latex. Although typing TMAs is slightly longer than hand written, the result of a typed TMA is much more satisfactory. It’s also much easier to correct TMAs.
• I get to learn some more LaTeX and Mathematica tricks.
• They gave me a natural opportunity to improve on my LaTeX experience.

The vertical scale indicates the number of responses.
Negatives
Seventy-five students provided at least one comment in the negative category, giving a total of 136 in this category. Many of these comments were specific to maths eTMAs (e.g. the difficulties of getting notation correct) or to the non-standard submission route used for maths eTMAs. The negative comments tended to be more diverse and were more likely to be affected by the preparation method chosen by the student although, overall, those typesetting are not any more or less negative about maths eTMAs than those handwriting.

Below the chart is a selection of the comments that cropped up in the ‘other’ category.

Pedagogical

*From those typesetting*

- Because of the electronic process it’s not that difficult to cause mistakes because of simple things like the “wrong” copy/paste.
- There was a definite lack in the quantity of comments on marked eTMAs compared to handwritten ones.
- Although difficult to judge, I suspect that an electronic TMA is harder to mark from a tutors perspective than a written TMA. This is perhaps reflected in the amount of comments written on the TMA. It’s much easier to circle and make corrections on a written TMA compared to electronic.
- Tutors are going to find it more difficult to put in a few extra comments.
• Spending too much time on formatting and worrying about the presentation of the final document.
• Not as good preparation for the exam.

From those handwriting
• Not as easy to refer to tutor’s comments in future studies.

Psychological / physical

From those typesetting
• Word processors do not have the directness and flexibility of paper (though I know I could have hand written and scanned)
• Not having a brown envelope to open when the TMA was returned.
• On a more personal/psychological note, having hand-written comments on a TMA is more personal. It’s quite “nice” to have hand written ticks and comments – the electronic ticks and comments seem impersonal. Not sure what can be done about this though! (unless the tutor posts the TMA back with written comments.)
• Spending yet more time at a computer (it’s also my day job).

Technical

From those typesetting
• The bias towards Microsoft product and platforms. The Open University is supposed to be *OPEN* - so it would be nice if it used open software rather than proprietary software.
• Word 2007 is unstable.
• Multiple copies of the files on the computer – separate questions, then the completed document, then the zipped version, then the returned version.
• When my work system got updated it changed to the new version of word which is not accepted by the eTMA system so it was frustration having to change the format etc...

From those handwriting
• I felt my scanning software was producing somewhat feint images, wasn’t totally sure they would be clearly legible. This wasn’t an issue with my tutor and I could read the returns OK, but I would rather they were bolder.
• Have to rely on a broadband connection to a certain extent – large size attachments.
• Need for a scanner.
• OU not supporting ME.

Maths eTMA system and main eTMA system
• Always the worry that the submission system is down for maintenance when submitting at the last possible minute. I know we should always allow for that.

From those typesetting
• Could be easier to get replies to go to more than one email address. I used the OU mailbox to submit, but it would have been convenient if I could have had the replies copied to another email account.
• It was difficult to read through TMA before submitting it, leading me to print the whole thing off to proof read it.
• Would prefer a single return file including PT3, inline comments and inserted sheets for student handouts etc.
From those handwriting

- Zip-files. Why can’t I e-mail my files separately?
- Zip files or self-extracting exe file on return. Too much choice – make it one or the other.

Future of maths eTMAs

Of the eighty-four students who completed the survey, just over 90% said they would be very likely to submit maths eTMAs in the future, if given the option of doing so, and a further 7% said they were fairly likely to do so. Only two students indicated that they were not very likely to submit maths eTMAs again, and these had both used Word 2007.

Sixty-two of these students then responded to the question about what, if anything, they would change about how they prepare their maths eTMAs in the future, as follows.

- ‘Invest in software for mathematical notation’ includes students who said they would want to acquire such software, as well as those who said they wanted to ‘upgrade’ from, or learn better how to use, whatever they currently have. Of these, 10 students specifically mentioned Word 2007, two mentioned LaTeX, and the rest were non-specific or said something like ‘an equation editor’.

Interesting quotes from the ‘other’ category include the following.

- Nothing. I would ask that the tutor be given better tools to mark eTMAs though. The eTMA system should result in better (and easier) marking from the students and tutors point of view. If it’s more difficult to do and the results aren’t satisfactory then it fails in its objective.
- As far as possible, I would avoid the use of Maple – although this is course specific. Other than that, I don’t think I would change anything.
- Higher file size limit so I could scan handwritten TMAs.

Word 2007

The final section of the survey was addressed only to those students who had used Word 2007 to prepare their maths eTMAs: there were 40 respondents. Responses about how strongly they would recommend use of Word 2007 to other students on maths courses were as follows.
Comments on Word 2007 and its use included the following.

**Positives**
- *Equation Editor* is messy, difficult to understand, unforgiving, and very tricky to correct. The facilities of within Word 2007 are different and require learning, but are much superior. After the initial unfamiliarity, Word 2007 is an improvement on previous versions. The OU guide on the features is good.
- I think once I get used to Word 2007 it would be straight-forward to submit maths eTMAs.
- Once I know how to use it properly I think it will be even more usefull! 😊
- The integrated equation editor makes the difference. Otherwise OpenOffice would be fine.
- It has so many more advanced features and it is extremely user friendly.
- Not only has Word 2007 got excellent document formatting/preparation capabilities, but it has a very good “equation editor”.
- It takes time to find all the facilities, but it is a superb piece of maths software.
- I feel that using the equation editor and/or Mathtype is a good introduction to using Latex.
- Word 2007 is significantly better than previous maths editors and better than Maple 8 (not used later versions) but takes significantly longer to prepare than hand written scripts

**Negatives**
- Time consuming to try and figure out how to insert some of the mathematical symbols.
- Not user friendly for maths students.
- Very slow, but still quicker than Mathtype!
- Wasn’t too keen on the equation editor in word 2007 – I preferred Mathtype. Although I had used Mathtype before I started to use word 2007, which probably affected my judgement.
- The equation feature is improved compared with previous versions of Word. However, I hate the layout – they’ve hidden all my favourite buttons and this makes some things slower for me. There is an add-in that you can download that allows you to save your final version as a PDF file, which can be useful – once you’ve PDF-ed it, you can check it knowing nothing else can change (though if there’s a mistake, it is back to square 1!). Also, the PDF-conversion isn’t fail proof, which some students might not be aware of.
- It’s a rubbish product – menus are confusing, it takes up too much memory. Stick with MS Office 2003 or Office XP
- I’ve had some problems with Word 2007 shutting down and not being able to re-open the document and have had to redo some work.
- I think maths students should be taught to use more specific software like LaTeX. I think Word 2007 is not very useful writing maths.
- Very good with built in equation editor. Cheap version available to students is needed. Not sure OU should be completely tied in to Microsoft though.
- Don’t use it, don’t use Windows and don’t want to use it!

**Support**
- A best practice document for maths presentation might be useful. [A guide to the maths features of Word 2007 was made available to the students part way through the trial.]
- Word 2007 can be quite heavy to understand so I think a sample eTMA designed to use specified functions would be a good idea rather than leave it to the student to produce their own. This should use the most likely used features of Word 2007 to give the student the appropriate practice in the use of the tool.
- Would like the opportunity to attend the Latex session another time
 Technical issues

No more than 10% of the students who submitted eTMAs had cause to contact the University about their maths eTMAs suggesting that the process worked well for those who participated. A small number of students experienced difficulties or problems, and raised these either in emails to the maths-etma-help mailbox, on the student conference, or via their tutor. The numbers and main categories of queries and comments received are as follows.

<table>
<thead>
<tr>
<th>Issue</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
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<td>5</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>Images</td>
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<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Types of document</td>
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<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
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<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
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<td>4</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>From non-trial students</td>
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<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>TOTAL</td>
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<td>15</td>
<td>11</td>
<td>12</td>
<td>9</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>57</td>
</tr>
</tbody>
</table>

Within these the main issues raised, and the count of times mentioned, are as follows (noting that in some cases an issue was raised by the same student on more than one occasion).

Zipping
- How to compress large files [11]

Images
Various different queries

Types of document

Previewing documents
- How to (with older version of Word / on a Mac) [5]

Submission
- Trying to use link on StudentHome [5]

From non-trial students
- Want to submit maths eTMAs [3]

Conclusions

Student perspective
The option of submitting mathematical assignments electronically is popular with students, although there is a need for a simpler submission process. For students the principle of flexibility in how they create assignments is beneficial. Overall, students appreciate the quicker return of feedback and improved legibility, and found their tutor’s feedback to be of excellent quality. Electronic submission of mathematical work can affect the way students work and may require investment of time and effort in developing skills, but many students consider this time well spent.

Tutor perspective
Depending on their style of paper-based marking and the nature of the assignment, tutors developed subtly individual approaches to e-marking. Preferences were also dictated by the hardware available to each tutor, as tutors are expected to use their own computer hardware. Their
confidence with each software option for marking was also a factor in the approach adopted. For example, those with access to reliable inking technology made extensive, and in some cases exclusive, use of it, whereas others adopted a more mixed mode. The small graphics tablets were generally found to be unsatisfactory, whereas Tablet PCs were rated highly by users.

The format of the student’s work also influenced the marking style developed. Assignments submitted as scans of handwritten work, for example, were received by the tutor as a series of embedded images in a Word 2007 document, in which typed comments had to be applied via textboxes overlaying the student’s work.

Most tutors very quickly naturally sought a method of annotation which facilitated rapid communication of their reactions through comments and explanations placed precisely at the relevant point within the student’s work. However, this ‘flow’ of thought tended to be inhibited rather than aided by the technology, with tutors reporting difficulties in positioning textboxes, adding ticks, scrolling through lengthy assignments and multiple document formats. The impact of this was to make the e-marking experience less convenient and more time-consuming and stressful for the majority, as compared to paper marking. Those using approaches which preserved the ‘flow’ of marking, notably those using track changes or reliable methods of inking found the e-marking experience more positive.

Subtle changes in approach became apparent towards the end of the trial, primarily through the tutors’ open responses to the questionnaire. Recognizing that the effort required was unsustainable there were regretful suggestions that they may need to use a less-rich mix of annotations (ticks, highlights, typed or inked comments, etc) and increase their re-use of comments across scripts, despite the potential for a perceived reduction in personalization. Some tutors reduced their emphasis on positioning feedback close to the relevant point in the student’s work. Some suggested restricting the students’ choice in preparing assignments, for example, by constraining them all to use Word 2007, or all to handwrite and scan.

In summary, the importance for tutors to be able to respond to what the student has written without essentially any interruption to the flow of their thoughts has been confirmed. The project has also provided additional insight into how tutors respond to mathematical eTMAs, which is both individual and complex, and into the facilities required to maintain quality correspondence tuition electronically. E-marking of maths eTMAs can place unreasonable demands on tutors, demands which aren’t sufficiently alleviated by the essentially software-only solution adopted in the trial.

Recommendations

The following recommendations derive from a thorough review of feedback on the trial provided by both tutors and students. A few are already being addressed as further roll-out of maths eTMAs takes place, but a significant number need to be considered at an institutional level. However, it may be appropriate for the University to undertake a more fundamental review of how feedback on symbolically-rich assignments might be provided through electronic means.

Hardware and software for tutors

1. Provision to tutors of a range of hardware and software tools which facilitate different marking approaches, minimise marking time and take account of health and safety considerations.

2. Tutors provided with clear advice about their options in hardware and software tools, so that they can make an informed choice about what might suit them. The opportunity for tutors to try various options before marking ‘live’ eTMAs would be desirable.

3. If Word 2007 is adopted as a primary marking tool, further development of the MOL marking ribbon, specifically to facilitate:
   • efficient insertion of ticks and short annotations;
• positioning of textbox at insertion point;
• efficient mark insertion and automatic totalling.

4. Steps to be taken to minimise the risk of the formatting or content of students’ work inadvertently being modified during the process of marking and commenting by tutors.

5. Continuing market surveillance of cost-effective inking technology.

6. Further investigation of options for easy creation and insertion of diagrams.

**Support for tutors**

1. Resource and time provided for tutors to explore e-marking options and to become accustomed with unfamiliar hardware, software and systems.
2. Appropriate recompense to tutors for training, familiarisation and the extra time needed to work on maths eTMAs.
3. Initial training in all aspects of dealing with maths eTMAs provided, ideally through a combination of screencasts and follow-up synchronous training sessions.
4. Provision of on-going support via online conferences and a ‘buddy system’ led by experienced maths eTMA markers.
5. Rationalisation of the documentation and guides to eTMA marking in mathematics.
6. Provision of TMA solutions and relevant diagrams in a form that tutors can easily incorporate into their annotations of students’ work.

**Use of eTMA systems by tutors**

1. Modification of the main eTMA system to accommodate split TMAs (in a way that doesn’t interfere with TMA00). Alternatively, review the policy of including split TMAs in maths courses.
2. Provision of greater choice of file type to tutors by, for example, allowing them to opt in to receive certain file types (e.g. LaTeX) without processing by the maths eTMA system.
3. Integration of the PT3 feedback with the TMA document itself, with automatic transfer of marks from the TMA to the PT3, and automatic addition of marks on both the PT3 and the TMA itself.
4. Facility to include notation on the PT3.
5. Removal of the file size restriction for tutors.
6. Automatic conversion of marked eTMAs to PDF before return to the student.
7. Tutors allowed to return a second copy of a marked assignment in the event that they inadvertently submit the wrong file(s) in the first instance (c.f. multiple submissions from the student are permitted).

**Submission to eTMA systems by students**

1. Provide the guide to maths eTMA for students, and only that guide, directly to relevant students.
2. Provision of clearer instructions on the submission of maths eTMAs (possibly consider offering a downloadable on-screen demonstration).
3. For courses which use specific software, such as Mathcad, Maple and Minitab, each course team to have a clear policy on whether students are expected to submit ‘live’ application files or a PDF version (or similar), or both. Similarly, tutors provided with clear instructions about the marking and return of such files.
4. No restriction on the file size submitted by students given that the maths eTMA processing will reduce the file size to acceptable limits before the document(s) are checked by the student.
5. Ideally, students would not have to zip up multiple files before submission.
6. Facilitate automatic notification to students when the maths eTMA system is not available.
7. (a) Students to be able to submit maths eTMAs directly to the main eTMA system (with the necessary processing and previewing taking place within that system);
or
(b) Students to be able to submit eTMAs to the maths eTMA system from their StudentHome page (and the link to the main eTMA system disabled on relevant courses).

8. Until such time that the main eTMA system is modified to accommodate maths eTMAs it is made as clear to students that they must not submit directly to the main eTMA system (preferably by removal of the relevant link on StudentHome).

9. Students to be able to upload eTMAs via a web service with the facility to preview their processed maths eTMA before committing to submit it.

10. Reduction in the number of receipt emails (requires faster processing and forwarding so that stages are combined).

Preparation of eTMAs by students
1. The principle of flexibility for students in terms of how they prepare work is upheld.
2. Students are informed about the option of submitting eTMAs as early as possible, and preferably as part of the course description.
3. Students are made aware that electronic submission does not necessarily imply electronic preparation of responses, accepting the need to scan handwritten work.
4. Students are encouraged to submit a test eTMA as early as possible after course start, that includes examples of the file types and formatting they expect to submit for assessment.
5. Students are informed about the pros and cons of different approaches to preparing work for eTMAs, particularly with respect to mathematical notation and production of diagrams.
6. Students are given clear guidance on scanning TMAs and how to process them into image files or into a PDF, and how to avoid pages in the wrong orientation etc.
7. Students are warned that preparation of typeset work is likely to take longer, at least initially.
8. Students who wish to typeset mathematical content are given access to appropriate support documents for popular options, such as Word 2007 and LaTeX, and possibly relevant training (face-to-face or online).
9. Students who have Word 2007 are made aware of its mathematical facilities.
10. Students are given clear instructions, preferably within their assignment instructions, about how to submit printout from course software (i.e. whether it should be embedded in another file, converted to a different format, submitted as a live software file, or ...).
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Appendix A: Tutors’ detailed comments on the systems, hardware and software used

A substantial separate appendix containing tutors’ detailed comments on their experiences of using the systems, hardware and software on the trial is available on request from the report authors.

Appendix B: Setting the trial and its conclusions in context by comparison with related work

This purpose of this appendix is to give the maths eTMA trial and, particularly, the results drawn from it, a broader context in terms of related research and projects from the Open University and elsewhere. In order to make the connections between other work and the trial clear, the conclusions from the maths eTMA trial are interspersed (in italics) at appropriate places.

Tutor perspective

Recent technological developments have opened up possibilities for tutors to annotate mathematics eTMAs submitted in a variety of document formats. Other trials in similar curriculum areas (McLaughlin, Kerr, & Howie, 2007), (Fisher [1], 2008), (Underwood & Freake, 2007), (Steinweg, Williams, & Warren, 2006) have adopted a hardware approach through the provision of Tablet PCs to facilitate digital inking. Within the OU (Underwood & Freake, 2007) and (Fisher [2], 2008) provided Toshiba Tecra M4 Tablet PCs pre-loaded with Windows Journal software. Underwood and Freake additionally provided software for annotating PDF files (PDF Annotator). Each of these trials was relatively small scale, involving less than 30 tutors on a second level physics course (Underwood and Freake) and five technology tutors (Fisher). In contrast, in mathematics, introduction of eTMAs could potentially involve around 500 mathematics tutors and it is not feasible to provide this number of Tablet PCs. Consequently we undertook to trial a more cost-effective software solution. In another software-based trial (Denton, Madden, Roberts, & Rowe, 2008) in which feedback was emailed directly, students felt that this increased the quality, legibility and timeliness of the feedback. However, feedback was divorced from the student’s work and there was a suggestion that this was undesirable. We feel that this would have even more of a negative impact in mathematics assignments where tutors often need to highlight a very specific part of the student’s solution (Steinweg, Williams, & Warren, 2006).

It is widely recognised that good quality feedback is required to reduce the gap between the learner’s performance and the ‘reference level’ (Ramprasad, 1983) set by the course teaching materials. Effective feedback motivates and enhances learning, reflection and understanding (Orsmond, Merry, & Reiling, 2005) and fosters deep learning (Higgins, Hartley, & Skelton, 2002). (Swan, 2001) and (Glover & Brown, 2006) highlight the importance of the quality of feedback to students’ learning. However, (McLaughlin, Kerr, & Howie, 2007) and (Gibbs & Simpson, 2004) found that students value timeliness of feedback over its specific content. Principles of good feedback have been identified by several authors (Gibbs & Simpson, 2004), (Chickering [1] & Gamson, 1987), (Chickering [2] & Gamson, 1991) and (Nicol & Macfarlene-Dick, 2006).

From early in our trial, it was clear that some effort is required for tutors to become familiar both with the systems required to access and return eTMAs and with the software used in e-marking. (Underwood & Freake, 2007) also noted that significant initial learning time was needed. A number of tutors in the maths trial did not receive sufficient electronic submissions to become really familiar with using the eTMA system and with e-marking. This was also apparent in Underwood and Freake’s work where, of four tutors who expressed a preference for paper marking, three had marked fewer than ten eTMAs. Both trials therefore indicate that initial investment of time is needed for tutors to gain ‘ownership’ of the technology and how it is best used (Conole, de Laat, Dillon, & Darby, 2008).
The maths tutors were initially provided with documentation on using Word 2007 and its mathematical features, and were also given a quick guide with a suggested style of marking to help get them started, though they did not make extensive use of either of these. (Blin & Munro, 2008) argue that tutors will try to replicate what they already do instead of reassessing their practice. Nevertheless one outcome of this study is to collect together a range of examples of e-marking and tools used. It is anticipated that such examples of good practice would be more effective with other tutors than formal documentation because they have been developed by peers and consequently will be seen to be more relevant (McLaughlin, Kerr, & Howie, 2007).

Depending on their style of paper-based marking and the nature of the assignment, tutors developed subtly individual approaches to e-marking. Preferences were also dictated by the hardware available to each tutor, as tutors are expected to use their own computer hardware. Their confidence with each software option for marking was also a factor in the approach adopted. For example, those with access to reliable inkling technology made extensive, and in some cases exclusive, use of it, whereas others adopted a more mixed mode. The small graphics tablets were generally found to be unsatisfactory, whereas Tablet PCs were rated highly by users.

(McLaughlin, Kerr, & Howie, 2007) and (Jennings & McCuller, 2004) also found that tutors in their studies of electronic marking developed subtly individual approaches to e-marking.

The format of the student’s work also influenced the marking style developed. Assignments submitted as scans of handwritten work, for example, were received by the tutor as a series of embedded images in a Word 2007 document, in which typed comments had to be applied via textboxes overlaying the student’s work.

Those tutors who had access to reliable inkling could deal with these more easily whereas those relying on typing had little option but to type comments in textboxes. Using a GOMS\(^7\)-based approach (e.g. (John & Kieras, 1996)), it can be seen that the time needed to perform the necessary sequence of operations in positioning textboxes will be greater than simply entering a comment, whether typed or inked.

The maths tutors experimented with the tools available for providing feedback, and typically expended significant time and effort to match the quality and quantity of feedback given in traditional paper marking. However, even as ‘early adopters’ (Kirkup & Kirkwood, 2005) of the given technologies, the tutors’ willingness to experiment was generally not sustained throughout the trial.

Most tutors very quickly naturally sought a method of annotation which facilitated rapid communication of their reactions through comments and explanations placed precisely at the relevant point within the student’s work. However, this ‘flow’ of thought tended to be inhibited rather than aided by the technology, with tutors reporting difficulties in positioning textboxes, adding ticks, scrolling through lengthy assignments and multiple document formats. The impact of this was to make the e-marking experience less convenient and more time-consuming and stressful for the majority, as compared to paper marking. Those using approaches which preserved the ‘flow’ of marking, notably those using track changes or reliable methods of inkling found the e-marking experience more positive.

(Jennings & McCuller, 2004), (Kirkup & Kirkwood, 2005) and (Popyack, Herrmann, Char, Zoski, Cera, & Lass, 2003) all report that electronic marking is more time consuming than paper-based marking. In contrast, (Fisher [2], 2008), (Underwood & Freake, 2007) and (Steinweg, Williams, & Warren, 2006) found that e-marking was less time-consuming. It should be noted, however, that participants in the studies of Fisher and Steinweg et al had prior experience of e-marking, and that participants in all three studies used digital inking on Tablet PCs. (Plimmer & Mason, 2006) see one of the main advantages of digital inking as allowing quick commenting and rich feedback. (Underwood & Freake,

\(^7\) Goals, Operators, Methods, Selection rules
2007) assert that digital inking on Tablet PCs allows tutors to mark electronically in exactly the same way as on paper. (Adams & Fisher, 2007) took this further, arguing that tutors formed a ‘symbiotic relationship’ with the Tablet PC which resulted in tutors’ comments having greater depth than when using a desktop PC, although overall the quantity of feedback given was reduced. We see no evidence of such a relationship with the hardware developing in the maths trial, which is probably due to the fact that tutors here are moving from paper marking to e-marking. In Fisher’s trial, tutors were already familiar with eTMAs and the introduction of inking on Tablet PCs enabled them to return to an approach which more closely replicates paper marking. The transition made by tutors in Fisher’s trial and that made by those in the maths trial are therefore in opposing directions. The symbiotic relationship between the user and the Tablet PC for eTMAs could be seen to approximate to that between the marker and pen for paper TMAs.

The relationship between reading and annotation as ‘active reading’ is well documented (Skeans, 2000) and can be extended to electronic annotation (Foster, 2005), (Marshall & Brush, 2004). Annotation, whether handwritten or electronic, is important in facilitating the marker’s engagement with the text and understanding of the intentions of the student (Marshall & Brush, 2004), and thereby enhances student-centred learning and promotes giving feedback which is relevant and individualised (Ball [2], Franks, Jenkins, McGrath, & Leigh, 2009). Moreover, (Lizzio & Wilson, 2008) found that students appreciate such feedback, seeing it as evidence of a deeper engagement with their work. It establishes interaction between the tutor and student (Agosti & Ferro, 2007), and students feel valued and are more likely to take the feedback on board (Lizzio & Wilson, 2008). It is imperative therefore that the technology used to provide such annotations (feedback) on the student’s work, does not interfere with this process.

Subtle changes in approach became apparent towards the end of the trial, primarily through the tutors’ open responses to the questionnaire. Recognizing that the effort required was unsustainable there were regretful suggestions that they may need to use a less-rich mix of annotations (ticks, highlights, typed or inked comments, etc) and increase their re-use of comments across scripts, despite the potential for a perceived reduction in personalization. Some tutors reduced their emphasis on positioning feedback close to the relevant point in the student’s work. Some suggested restricting the students’ choice in preparing assignments, for example, by constraining them all to use Word 2007, or all to handwrite and scan.

It is recognized that the relationship between tutor and student is important to learning. In distance education there are barriers to establishing this relationship (Swan, 2001). In particular, when most contact is via feedback on assignments, there are particular challenges (Rowe [1] & Wood, 2008), (Steinweg, Williams, & Warren, 2006), (Jennings & McCuller, 2004), (Roberson & Klotz). Annotations on students’ work convey a tone, either positive or negative. This may affect the student’s confidence and whether a good rapport is established (Ball [1], 2009), (Ball [2], Franks, Jenkins, McGrath, & Leigh, 2009), thus potentially impacting on the quality of the student experience (Higgins, Hartley, & Skelton, 2002). Personalisation of feedback is valued by students (Rowe [2], Wood, & Petocz, 2008) and creating a dialogue is often crucial for students to understand the significance of the feedback provided (Nicol & Macfarlane-Dick, 2006). (Ball [2], Franks, Jenkins, McGrath, & Leigh, 2009) also comment that the absence of ticks is detrimental to the student experience. Concerns were voiced at the beginning of the maths trial about the potential for loss of personalization in feedback on eTMAs, arising as a result of the extra time required for e-marking.

Throughout the maths trial, the potential to re-use comments and to use model solutions by cutting and pasting was highlighted as a benefit of e-marking and a factor which could mitigate the extra time needed for e-marking. This is consistent with previous work (Underwood & Freahe, 2007), (Fisher [2], 2008). However, amongst the maths and statistics tutors on the trial it was felt that significant re-use of comments would lead to less personalization of feedback. (Denton, Madden, Roberts, & Rowe, 2008) also report that students found the use of a statement bank and model answers impersonal and uniform. Another drawback of using model solutions is that they tend to
focus on factual knowledge and the presentation of the solution, rather than promoting a deeper understanding (Draper, 2009), (Biggs, 2003)). By the end of the trial, and despite these concerns, tutors were indeed beginning to make increasing use of pre-prepared comments and model solutions. We contend that this is a direct result of the extra time needed to mark electronically, as observed by (Popyack, Herrmann, Char, Zoski, Cera, & Lass, 2003) and (Jennings & McCuller, 2004). Both these studies found that markers were either spending considerably more time marking or were not giving the desired level of feedback.

By the end of the trial, tutors were beginning to reduce the emphasis on providing the feedback close to the student’s work, which impacts on how the feedback is interpreted and assimilated by the student (Marshall & Brush, 2004), (Wolfe, 2000).

In this trial, we have seen that many tutors started to compromise quality in favour of taking a more pragmatic approach to e-marking assignments. As described above, there were signs that the quality of the feedback, personalisation and dialogue with the student were beginning to suffer. We saw little evidence that tutors were prepared to reassess their own practice in a more radical way, which is consistent with the observations of (Blin & Munro, 2008) and (Brill & Galloway, 2007). Blin and Munro argue that this is due to competing demands on their time, but also due to lack of competency in the technologies, poor training and resistance to change. (Åkerlind [1], 2003) and McKenzie (2003, in (Åkerlind [2], 2007)) have both shown that the first reaction to any change in teaching starts with a focus on the teacher, in order to increase the teacher’s comfort, confidence and efficiency. Only after that does the focus shift to the student, with the teacher then addressing how to harness the change to enhance the learning experience of the student. In this trial, we have observed the first stage, but not the second. We contend that the tutors have not had sufficient experience during this trial to really move to the latter stage.

Overall, the positive aspects of electronic assignments identified in this trial, including improved legibility of annotations, the ability to cut and paste and to revise comments, and for (potentially) faster turnaround time, apply across the curriculum, not just to eTMAs in symbolically rich subjects.

The negative aspects are also mostly generic, including the difficulty of scrolling, of inserting diagrams, of switching between assignments, and the limitations in when and where assignments can be marked, with associated health and safety issues in using a computer for long periods. These benefits and problems were also identified in previous work (Underwood & Freake, 2007), (Fisher [2], 2008). There are only a small number of negative aspects particularly related to the maths trial, such as the need to use textboxes to overwrite embedded images.

In general, despite the difficulties encountered, tutors on the trial did perceive that students gained added value from eTMAs. Both this trial and previous work (Underwood & Freake, 2007) have shown that tutors value the ‘professional look’ of an electronically marked assignment. Tutors appreciated the ease of erasing comments which were incorrect or messy. Tutors on the trial also generally felt that the quality of feedback on eTMAs was better than on paper. Tutors felt overall that they wrote more and appreciated the ease of adding extra space to allow feedback to be positioned close to the relevant point in the student’s work. (Kirkup & Kirkwood, 2005) also report that the quality of feedback in electronic marking is improved, but comment that the increased value to students does not outweigh the extra burden on tutors in providing the feedback.

In summary, the importance for tutors to be able to respond to what the student has written without essentially any interruption to the flow of their thoughts has been confirmed. The project has also provided additional insight into how tutors respond to mathematical eTMAs, which is both individual and complex, and into the facilities required to maintain quality correspondence tuition electronically. E-marking of maths eTMAs can place unreasonable demands on tutors, demands which aren’t sufficiently alleviated by the essentially software-only solution adopted in the trial.
Student perspective

The option of submitting mathematical assignments electronically is popular with students, although there is a need for a simpler submission process.

Overall, students appreciate the quicker return of feedback and improved legibility, and found their tutor’s feedback to be of excellent quality.

This is consistent with feedback from students on a previous trial of electronic marking (Underwood & Freake, 2007).

For students the principle of flexibility in how they create assignments is beneficial. Electronic submission of mathematical work can affect the way students work and may require investment of time and effort in developing skills, but many students consider this time well spent.

(Kirkup & Kirkwood, 2005) similarly report that students value the skills learnt in preparing assignments electronically. However, for most maths students time is better spent learning the subject than spent typesetting, and there are pedagogic advantages to handwriting mathematics (Anthony, Yang, & Koedinger, 2008). By the end of the trial, some tutors suggested restricting the students’ choice in how they prepare assignments, for example, by constraining them all to use Word 2007, or all to handwriting and scan. However, we contend that students should have freedom of choice in this.