1. INTRODUCTION

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

Although electronic assessment (eAssessment) is growing rapidly in the university sector as a whole, and in the Open University in particular (see [1]), eAssessment 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 (see, for example, [2]), such systems are still a long way from being able to handle sophisticated mathematical argument, nor do they provide the level of feedback required for correspondence tuition. Another approach (described here) is to facilitate electronic marking by human markers, as discussed in [3]. (See also [4] for work in the secondary school sector.)

There are approximately 15,000 students registered on Open University mathematics courses, who submit, for each course, between 4 and 8 Tutor-Marked Assignments (TMAs). These TMAs are summatively marked by 550 mathematics tutors, who provide extensive formative feedback, a key part of the correspondence tuition provided by the OU.

In total 85,000 mathematics TMAs are processed annually, almost all of which are sent through the postal system. This can be both expensive and slow (due to multiple handling) and it has hindered the expansion of the University’s mathematics offerings to the world stage, as delayed feedback is of much less use to students, especially in a cumulative subject such as mathematics.

Many parts of the University use electronic submission of TMAs (known as eTMA); however mathematics and other symbolically rich disciplines have hitherto retained postal submission, largely because of the difficulties in electronic submission and marking of mathematical material.

In this paper we describe an approach to electronic submission and marking of mathematics assignments using Microsoft Word 2007. (See Fig. 1.) The system is in the spirit, but distinct in detail, from other electronic marking approaches such as outlined in [3] and the online marking of examinations as pioneered by the UK public examination provider AQA [4].

Microsoft Office Word 2007 is XML-based and supports advanced mathematical typography, but with a choice of easy-to-use input methods: a linear text-based approach and a more graphical palette-based approach. (See [5] for details of Word 2007’s mathematical capabilities.) Moreover, the OpenXML packaging convention facilitates programmatic construction of Word 2007 documents. Indeed, Word 2007 has many features that make it attractive as a mathematics marking tool, viz:

a) dual input modes: an easy-to-use graphical user interface (GUI) integrated with a TeX-style linear input syntax mode;

b) easy toggle between mathematics and normal text input modes;

c) TeX-inspired typography, with instant build up from linear to ‘professional’ rendering;

d) in-built annotation tools such as textboxes, callouts, arrows, etc.
2. DESCRIPTION OF MOL eTMA SYSTEM

The MOL eTMA system allows students relative freedom of choice in how they submit their work. Scanned handwriting, digital pen, pdf (produced from (LA)TeX or otherwise), Word 2003/Word 2007 are all possible input methods. Students submit their work (currently by email) to a preprocessor which converts it to a Word 2007 file for onward transmission via the University’s standard eTMA system to tutors for marking. The tutors receive the work from the University, proceed to mark it and then return it to the student (usually as a pdf file). (See Fig 2.) The tutors may either use the in-built commenting facilities of Word 2007, annotate through callouts and textboxes, or use in-built/third party inking tools for hand annotation either through a tablet PC or via an external tablet.

In addition, custom marking tools have been developed by MOL to help tutors mark electronically. These tools are of three basic types: page/image manipulation tools to help tutors deal with page order and orientation problems (arising from mis-scanning, for example); insertion tools to help with insertion of specific symbols (such as ticks) and pre-prepared comments, equations, diagrams and solutions; and mark insertion tools to enable the tutor to assign marks to question (parts) and to total the marks to be recorded and transmitted to the University and to the student. These marking tools are in still a developmental stage and are largely standalone; it is hoped to integrate them in the future with the University’s mark recording systems and to enable Web 2.0 collaboration between tutors to share repositories of equations, diagrams, solutions and related materials and best practice.

Fig. 1 Electronic marking with Word 2007

Fig. 2 Outline of the trial mathematics eTMA system.
3. KEY PEDAGOGICAL QUESTIONS

In addition to the technical and logistical issues of preparing, submitting, marking and returning mathematical work for assessment, electronic marking of student work raises important issues of a pedagogical nature. Key questions include:

a) What are the time and resource implications for electronic marking of mathematics?

b) In what way will the technological issues drive the pedagogy?

c) In what manner will electronic marking affect the way in which marking is conducted? Will tutors produce less detailed or less individualized feedback as a result of electronic marking and in what way will this affect the students’ learning?

4. eTMA TRIAL AND PRELIMINARY FINDINGS

In order to provide, at least, partial answers to some of the questions outlined above, the MOL project, in conjunction with the OU’s Centre for Open Learning of Mathematics, Science, Computing and Technology, has organized a marking trial consisting of 24 Open University mathematics tutors teaching across 13 pure and applied mathematics and statistics courses ranging from entry-level to postgraduate masters level. The trial will run in the period February – September 2008.

A clear initial finding is that tutors find electronic marking of mathematics assignments more time consuming and less convenient than conventional paper-and-pen marking, at least initially. This is particularly true for the feedback required for correspondence tuition. Despite the advantages that Word 2007 provides in terms of ease of input of mathematical expressions, it is nevertheless time consuming to input and position all but the most elementary mathematical expressions. It is still unclear to what extent the extra time required can be mitigated by the use of repositories of comments, equations, diagrams and solution so that markers can easily reuse material, not just from student to student for a particular assignment, but, more generally, within or between courses, and from year to year.

Of course, electronic marking has time-saving advantages for the marker too, in that marking errors can be readily corrected and solutions may be easily moved from a repository of pre-prepared work. Also, without the postal delays, students should, in principle, at least, receive their work back sooner. Given the cumulative nature of mathematics learning, early feedback should have significant effects on students’ learning. Whether or not this happens remains to be seen.

A key aim of the trial is to obtain an indicative answer to c) above. The trial will certainly address the question of whether the nature of feedback is affected by electronic marking; whether student learning is affected in any way will be considerably harder to assess.

5. REFERENCES


