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Review of Maple TA, Maplesoft’s Teaching and Assessment Package
(Release 2.51, trial version hosted by Adept Scientific)

Background

The Canadian firm Maplesoft produces a wide range of software, including the well-known interactive mathematical software Maple, now in version 10. Its Maple TA (MTA) is an online assessment system capable of handling most assessment tasks, but particularly designed for the assessment of mathematics, where it can call on the power of its Maple engine to probe deeper knowledge and understanding.

Earlier this year, the University of Warwick signed up for a 3-month trial of MTA with the UK distributor Adept Scientific, as part of a 2-year project to promote the take-up of Computer-Aided Assessment (CAA) in the Science Faculty. Initially, we tried to get MTA running on a Solaris server here (it runs on most standard platforms), but this failed, perhaps because our server was already configured to handle other applications and we didn’t have enough expert staff time to persevere. We then moved to a hosted service provided by Adept Scientific, and subsequently used MTA in tandem with Question Mark Perception (QMP) for a summative multiple-choice test in an elementary Number Theory module with 166 registered second-year mathematics students: MTA for 66 students in one venue and simultaneously QMP for the remaining 100 in another. This experience gave a useful comparison of the strengths and weaknesses of the two systems and formed the basis of our decision to buy a 12-month MTA licence for 500 students in the coming academic year.

The author of this review and an IT-savvy research student in the Engineering School co-operated in authoring and organising the above-mentioned test, and this review should be seen as a preliminary and surface judgement based mainly on this limited experience. Now that we have a licence, I hope to push the software closer to its technical and pedagogical limits next year in a series of summative tests (for the same number theory module) that explore MTA’s sophisticated functionality more fully. I hope then to be in a position to write a more searching evaluation for MSOR Connections based on that experience.

Starting

You can start at Your Class Home Page, where you are presented with a list of live links to all the assignments for your class. (The first thing you notice is the North-American terminology):
‘class’ might mean ‘programme-of-study/module/lecture-course’
‘instructor’ means ‘lecturer/course-organiser’
‘proctor’ means something akin to ‘invigilator’

Our single hosted class was unfortunately named “Warwick School of Engineering”, even though no Engineering students or modules were involved, and our efforts to get this changed before the summative MCQ test failed.

In addition to the assignments, you also get these links on the Class Home Page:
- Instructor login
- Proctor login
- Register as a student in this class
- View my results in this class

Note that students can register themselves individually for a class (and subsequently look at their results on submitted assignments). Alternatively, the instructor can register students en masse by uploading a comma-separated-value file with the appropriate fields, generated from a spreadsheet.

Writing Questions

Let’s suppose we want to create some questions and then build an assignment out of them. We therefore click Instructor login and see the page shown in Fig 1.

You click on Question Bank Editor, where you have the option of creating a new question bank or editing an existing one. Within each question bank you must create at least one topic, and within any topic you can create (or upload) any number of questions. If your class is a typical lecture course, this filing system is probably adequate for most needs.

Suppose, however, you want your questions to have wider currency, throughout the whole Science Faculty of a big university, say, with 100 or more classes. The default position is that question banks can only be seen and accessed from within the class they are associated with. A way round this is to share a class with another class, or in the case of 100 classes, to create a parent class where all the question banks are kept and share it with all other classes. I could find nothing in the Help menu about the procedure for sharing classes or the implications of doing so. I did not find the Help menu particularly helpful – its search facility merely gives you access to the words in an index of the kind you might find at the back of a textbook. (Added in proof: Maplesoft write that “the search view of the Help menu allows you to type in a word or string and will return the help pages that contain that word”, but I am not able to access this facility in my Firefox browser.) The Maple TA filing system would probably begin to creak for question banks from 100 or more classes, but Maplesoft have informed me that information fields can be added to any question in Maple TA. An information field consists of a name-value pair that can be created by the author of the question. For example, content = linear equations or difficulty = hard. The author can search on these information fields when building an assignment to find all the questions in a question bank that satisfy particular criteria.

To create a question in “Topic 1” of a question bank called “Test Bank”, you navigate quickly to the page shown below and click “Add a question” (note the other options in the left-hand pane: delete or rename the topic, change the order of the topics, delete or duplicate a question called “Test 2”, and so on).

The new window contains the options shown in Fig 3; in particular, the drop-down “Question Type” menu contains this list:
- Multiple Choice
- Multiple Selection (Multiple Response)
- True/False
-Clickable imagemap
- Matching
- Essay
Fill the blanks

Math/Science Questions
Maple-graded
Mathematical Formula
Numeric
Palette-based symbolic Editor

Multipart Questions

Inline

Multipart Question The first group (down to “fill the blanks”)

are self-explanatory. The Math/Science questions exploit the underlying Maple engine to handle sophisticated mathematical questions (such as: Give an example of a polynomial of degree 4 with one local maximum and two local minima). The multipart questions allow a more flexible approach to some of the types in the first group.

In the summative test mentioned at the outset, I used only multiple-choice questions (MCQs); I also would have liked to use multiple selection (response) questions (MRQs), but found the imposed marking scheme inappropriate. Because the test was for module credit, I did not use the “Feedback” or “Hints” options and did not have time to write model solutions. For the second part of this review next year, I hope to be able to say more about the other question types and feedback options.

I will now focus on the MCQ and MRQ functionality that Maple TA offers:

Multiple Choice Questions. The cited CAA test was the last of a series of four, which in total contributed 25% to the module credit. The first three were paper-based and marked automatically using an optical character reader. Each test comprised 11 MCQs, each with 5 parts: one correct answer, three distractors and an “I don’t know” option. The scoring was 3 points for a correct choice, 0 for a wrong choice, and 1 for “I don’t know”. The total was normalised by subtracting 8 so that 11 right answers scored 25 and random guessing got roughly zero.

I wanted to reproduce this marking scheme in the fourth CAA test, and this was easily achieved in Question Mark Perception, which allows the author to allocate a separate mark to each MCQ part and also allows one selected part (in our case “I don’t know”) to appear in final position when the order of the parts is randomised each time the test is delivered. Unfortunately, Maple TA is less flexible: in MCQ mode, a fixed number of points is allocated to the right choice and 0 to the rest. Moreover, I could find no option for calculating the final score (the total minus 8) when the student pressed the submit button at the end of this test (instant marking/grading are usually seen as one of the bonuses of CAA). To compensate, I went through each answer file changing the score from 0 to 1 for the choice “I don’t know”, and then downloaded the files to an Excel spreadsheet to calculate the final overall score out of 25.
Multiple Response Questions

The default grading scheme for Multiple Selection Questions (MRQs), as they call them in Maple TA takes a while to master. My philosophy for a multiple response question is:

1. Set the scene, describe some situation on which the parts of the question are based.
2. Make some statements about the situation, each of which is either true or false (or, if you really want full generality, undecidable, but let’s forget that frill). The statements can all be true or all be false, and usually one would allot the same score for correctly spotting a true statement as a false one.
3. For each statement (part of the MRQ), ask students to decide whether it is true or false, or say they don’t know, and set scores accordingly, preferably informing students of the details of the marking scheme.

In Maple TA MRQ mode, the grading scheme for an individual question is:

$$\text{Grade} = \frac{\# \text{correct choices} - \# \text{incorrect choices}}{\# \text{correct answers}}$$

In this formula:

- The “# of correct choices” is the number of “true” statements that a student correctly selects. In the case where there are no “true” statements, this value will be 0.
- The “# of incorrect choices” in the formula is the number of “false” statements that a student wrongly selects.
- The “# of correct answers” actually means the number of statements in the question that are true.

To explore the implications of this formula, let’s lay down some ground rules for multiple-response questions (MRQs) and look at a concrete example.

**Rule 1:** The statements that make up the choices are either true or false.

**Rule 2:** For each part of the MRQ, it is equally difficult to decide whether the statement is true or false (unlike competitions in popular magazines, which often make it humorously obvious which statements are false). I usually aim to satisfy this rule in my MRQs, although I freely acknowledge it’s not an exact science and anyway, what is ‘hard’ varies from student to student.

**Rule 3:** It is equally likely that a statement is true or false (so that, on average for a four-part question, one question in sixteen has all parts false).

For our concrete example, take a four-part MRQ and a model student who gets all four choices correct, that is to say, they select all the “true” statements and do not select any of the “false” statements. If, say, just one of the four statements is true, the student scores $$(1-0)/1 = 1$$ mark; if 3 statements are true and one is false, the student’s grade is $$(3-0)/3 = 1$$ again. And for the one question in sixteen where all four answers are false, the student scores $$(0-0)/0 = 0/0$$, which to any mathematician is an undefined quantity; however, Maple TA knows better and wisely interprets this to mean 1 again. Full marks every time! (Confession: I only managed to get my head around this formula after a lot of patient explanation from Maplesoft.)

So far, so good. But now consider the scenario in which all four answers are false. If a student selects just one of the four as correct, (s)he is awarded $$(0 - 1)/0$$ points and Maple TA interprets this as 0. Likewise, a student is also graded zero for checking 2, 3 or 4 buttons in such a question. Thus no grade distinction is made between a student who gets all four parts wrong and one who gets 3 parts right and just 1 part wrong.

In view of this anomaly, I would greatly prefer a set-up where the author has complete control over the grading (scoring).

Workarounds

In a recent transatlantic online tutorial with Maplesoft, I learnt that the limitations of these default grading schemes for MCQs and MRQs can be avoided by using the option of an “inline list question”, which allows multiple questions within a given question and provides a drop-down list of choices where each choice can be differently scored. But since many of my colleagues will be “basic users”, wanting to cobble together some quick quizzes without delving into the more powerful functionality, I think there is a strong case for giving authors maximal pedagogic flexibility in scoring the basic question types.

Creating an Assignment

When you click Assignment Editor in the Main Menu shown in Fig 1, you are taken to a page listing the existing assignments with a button to create a new one. You can click on an existing assignment to review and edit it. (But beware! An irritating feature I regularly came up against: when a user has not logged off correctly, a warning window appears stating that a student is still active and you are not allowed to edit it. The only way round this seems to be to make a duplicate of the assignment, edit that, and then delete the old one.) If you click “New”, you get the window shown in Fig 4 with four tabs.

Having named your assignment, you click the Select Questions tab and arrive at the screen shown in Fig 5.
You have immediate access to all the questions in all the topics of all your question banks created in this class (and if so arranged, question banks in all shared classes). You can upload ("add") your questions to your new assignment either one at a time or in groups. The ‘groups’ option lets you generate different assignments for each student by randomly choosing a fixed number of questions from each group. Here you can tell the software to scramble the questions on each assignment and award points.

The Set Policies tab gives the instructor very broad control over a number of management issues (mode of use; time limits; access to hints, feedback and solutions; invigilation; reporting, and so on).

The Review & Finish page provides a summary of the assignment and the policies you have enforced, with a chance to edit them or confirm them by clicking ‘Finish’.

**System Tools**

This final option in the Main Menu (Fig 1) lets you:
- Manage proctors
- View your MTA email inbox
- Edit your instructor’s profile
- Lock student access to registration
- Share the class (Ah! There it is)
- Upload files and folders to your class web site
- Create and deploy course modules (I have no idea what that means)

**Conclusion**

Despite the grumbles (inevitable in a review of this kind), this software worked effectively and robustly in a live CAA experiment. Its special strengths for assessing mathematics:
- Authoring of mathematical expressions using symbol palette/LaTeX/MathML
- Use of Maple engine to assess deeper conceptual understanding and to parse equivalent answers
- Generation of multiple questions from single template using random parameters
- Question banks, both in-house and from publishers, covering a wide range of mathematical fields

have not even been hinted at in this review. However, we intend to remedy this serious omission when we have put some of its sophisticated functionality to the test "at the chalk
face” during the coming academic year. Watch this space over the coming twelve months.

Supplier Comments from Maplesoft

1 “The search field for typing in a word in the help system can be found on any browser on Windows clients. On the Macintosh platform, the search capability is provided through the alphabet listing.”