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## **Module Facelift: Engaging Student Technology Teachers with Maths**

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### **Abstract**

*In recent years a First Year Mathematics module for student Technology teachers has undergone a significant redesign due to a combination of factors. In 2010 a new tutor took over the module and began to add more content to the existing course in order to encourage students to engage with online resources, but a total redesign was not possible due to the limitations of the existing Virtual Learning Environment (VLE) (Moodle 1.9). In 2012, with support from the Learning Technology Unit, this course was restructured on the new Moodle 2.3 site in order that a new tool for quiz authoring and delivery could be embedded within the course. Previous technologies available were limited in various ways; with the arrival of this new tool sophisticated questions can be delivered and activities can be accessed on and off campus. In addition to this, the new version of the course includes tools for social networking and collaborative learning.*

In this paper we discuss the current version of our Moodle 2 course in detail, explaining our reasons for incorporating the elements we have used. We talk about the journey from Moodle 1.9 to 2.3, reflecting on the amount of time needed to set up a course such as this and explaining the decisions we made. We also describe the quiz tool in detail, to provide readers with a review of the benefits of implementing this tool. We end with a discussion of future plans for the course, including suggestions for further embedding social networking and collaborative learning into the course.

### Module Content and Delivery

The Maths T1 module is part of the first year of a course for student Technology teachers, who will be teaching practical activities such as making things with wood, metal, etc., design, engineering and electronics in secondary schools. Between 20 and 50 students take the course each year, and most students already have Scottish Higher in Mathematics, though a few have other qualifications at various levels.

#### Module content

Table 1 shows the topics in the module. Apart from Complex Numbers, these are all topics which the students will have seen before. There is a tendency to assume that they have seen it all before, leading to low motivation, little engagement with the course and a rush to “finish by Christmas”.

**Table 1.** Maths T1 Topics

| Basic Maths     | Higher Topics                  | Additional Topics   |
|-----------------|--------------------------------|---------------------|
| 1. Arithmetic   |                                | 10. Complex Numbers |
| 2. Algebra      | 6a. Further Algebra            |                     |
| 3. Trigonometry | 6b. Trigonometric Functions    |                     |
| 4. Geometry     | 7. Coordinate Geometry         |                     |
| 5a. Statistics  | 8. Logarithms and Exponentials |                     |
| 5b. Vectors     | 9. Differentiation             |                     |

#### Resources

In the academic year 2010-11, when the current tutor took over, the module had been running for several years as a self-paced course (Pollock,2002) using the CALMAT Mathematics Software, developed at Glasgow Caledonian University. The new tutor has a background as a member of the CALMAT group which created the software and was experienced in using it for teaching.

CALMAT has 134 lessons and around 2000 randomised questions in Mathematics, designed for learners at the interface between school and university. These learning and assessment resources can be tailored to fit the needs of the course and student usage can be monitored by the management system.

CALMAT is an application which can be loaded onto a server and delivered on campus, and at Glasgow it was available on University labs and PC clusters and could be downloaded for home use. However, it is 16 bit software, now unsupported, and is incompatible with 64 bit versions of Windows 7, and with non-Windows operating machines; it does not run on the web, and is therefore not available through the University VLE.

The learning materials for the module were the CALMAT lessons. Assessment consisted of formative tutorials and topic tests for each topic, delivered using CALMAT’s Testing and Assessment System, TAS. Students could try the tutorials as often as they required. The topic tests formed the final assessment for the module; one attempt was permitted, with a possible resit at exam time if the student failed to achieve the pass criteria of at least 40% in every test and an average score of 50% or greater.

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The module's Moodle course contained course information and the CALMAT notes.

In 2011-12, CALMAT and TAS were still used for the mock tests and topic tests. However, it was becoming apparent that CALMAT would not be available for much longer and the tutor began adding links to suitable learning materials from sources such as MathCentre, StatsTutor and PurpleMaths to the Moodle course, alongside the CALMAT software and notes, with the intention that they would replace the CALMAT system as the delivery mechanism for the module.

The assessment facilities available in the Moodle 1.9 quiz were not adequate for Mathematics, not having the capability to input and manipulate mathematical expressions, and hence the maths-capable, standards-based assessment delivery system MathAssessEngine was introduced, using a Moodle plugin.

An experimental Moodle course was developed, containing online tests similar to the TAS tutorials. These did not cover the entire course, and even in the topics that were represented, not all the questions were converted to the new format. However, the availability of these tests off campus and at any time enabled students to study in more flexible ways. Development of standards-compliant assessment resources, which conform to the Question and Test Interoperability Standard, Version 2.1 (QTI 2.1) (Kraan et al, 2012), continued into the new academic year.

Although the students of the 2012-13 cohort were introduced to CALMAT, it was known that the software would only be available for that year and only on one University lab. This further restricted student usage of CALMAT and accelerated plans to move to alternative resources.

The screenshot shows a Moodle course page for 'Maths T1'. The page is titled 'Maths T1' and has a breadcrumb trail: 'My home / My courses / MathsT1 / Trigonometry 1'. The page is divided into several sections:

- Navigation:** Includes links for 'My home', 'Site home', 'My profile', 'My courses', and 'MathsT1'. Under 'MathsT1', there are links for 'Participants', 'Reports', and 'Trigonometry 1'. The 'Trigonometry 1' section lists various resources like 'CALMAT Notes and additional resources for Trigonometry...', 'Use Pythagoras to find the hypotenuse', 'Find the third angle of a right angle triangle', etc.
- Search forums:** A search bar with a 'Go' button and an 'Advanced search' link.
- Latest news:** A section titled 'Add a new topic...' with a list of recent posts, including 'New Questions more...' and 'October 1st and 8th - Self Study more...'. There is also a link for 'Older topics ...'.
- My Courses:** A section listing 'Maths T1', 'Moodle 2 Discussion', 'QTI/LTI Test & demonstration course', 'QTI Projects', and 'Niall's test course'.
- Upcoming events:** A section stating 'There are no upcoming events' with links for 'Go to calendar...' and 'New event...'. There is also a 'Recent activity' section below it.
- Trigonometry 1 topic page:** The main content area shows the 'Trigonometry 1' topic page. It includes a 'News forum' section with links to 'Maths T1 Course Information 2012-13', 'Maths T1 Introduction (Slides)', 'Introductions Forum', 'Topics Wiki', 'Topics Forum', and 'Mahara (EPortfolio)'. Below this is a 'Trigonometry 1' section with a 'Turn editing on' button. The content includes a description of the topic, a list of CALMAT lessons, and links to 'CALMAT Notes and additional resources for Trigonometry 1'. There are also sections for 'Pythagoras' Theorem' and 'Solving Triangles', each with links to external resources and specific learning activities.

**Figure 1.** New module: topic Trigonometry 1, showing learning material and question links

Moodle 2.3 became available for use at university in summer 2012, and with it the possibility of adding external tools into the course page using IMS Learning Tools

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Interoperability (LTI) version 1.0 (Severance 2010). The STACK question type, available in the Moodle 2.3 quiz, does provide support for Mathematics, but is restricted to use within the Moodle quiz. However, a new mathematics-capable assessment and test player, QTIWorks (McKain 2012), which can be launched using LTI and is capable of delivering the new questions conforming to the IMS QTI version 2.1 specification also became available at this time. QTIWorks has the additional advantage of delivering individual questions, and making questions and tests available in any LTI-enabled VLE, increasing the sustainability of the resources and the potential for sharing the questions and tests as OER. Using QTIWorks, accessed by LTI, the new QTI 2.1 questions and tests could be incorporated into the Moodle course for the maths module directly. The Moodle page illustrated in Figure 1 shows the individual questions indicated by blue External Tool icons.

Figure 2 shows a question within the learning material which can be re-randomised using the "Reinitialise" button. The calculator provided in the Accessories folder is also shown, used in scientific mode.

### Maths T1

My home / My courses / MathsT1 / Trigonometry 1 / Use Pythagoras to find a side in a right angle triangle

#### Use Pythagoras to find side in right triangle

In triangle ABC, angle B is  $90^\circ$ , the length of AC is 22 and the length of AB is 7.

Find the length of BC.

You may find it helpful to draw a diagram.

Give your answer correct to 2 decimal places.

20.86 Correct

Show Hint

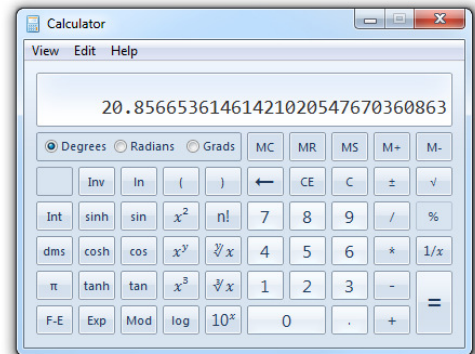
Show Solution

SUBMIT ANSWER

Reinitialise

Finish and review

Exit

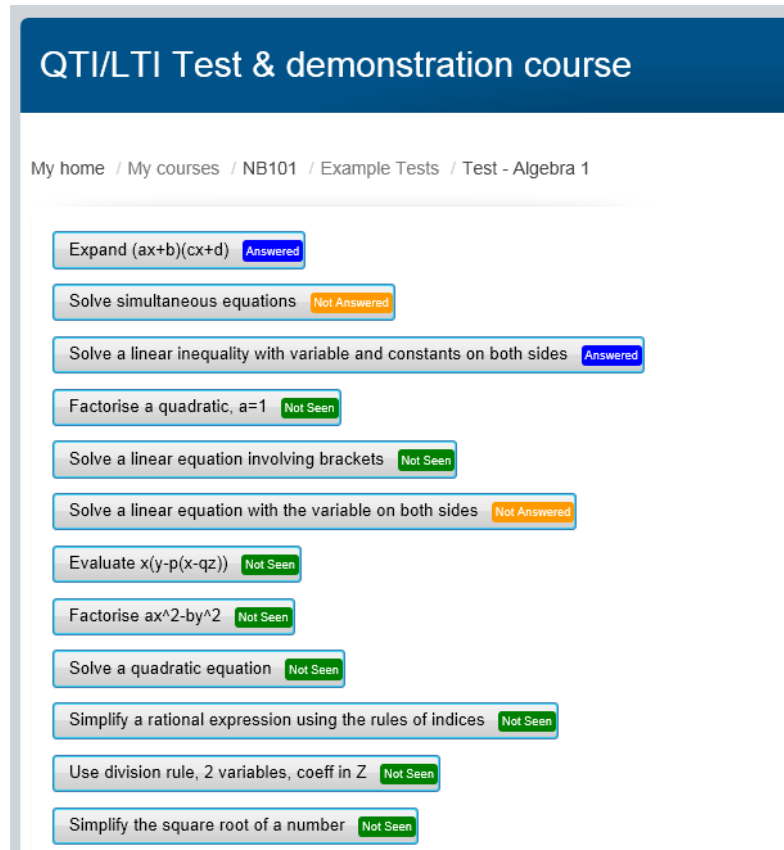


**Figure 2.** An individual question within the learning materials; note the Reinitialise button

More learning material was brought into the module's new Moodle course as links and downloads. QTIv2.1 questions were created for each topic, and for most subtopics, and all the topic tests were converted to QTI 2.1 assessments. Since the questions are randomised, each one can be used several times:

- As an individual question within the subtopic containing the relevant learning materials; the question parameters can be recalculated as often as the student requires;
- As part of a randomised mock test at the end of each topic, which students can repeat as often as they wish;
- As part of the topic test at the end of the topic; these are available only during supervised class times, and marks are collected only for attending students.

The Test Question Menu shown in Figure 3 is for the first Algebra test; the same test is used in the demo course being developed to train colleagues in the use of the assessment tools.



**Figure 3.** Test Question Menu

These resources constitute a reasonable alternative to CALMAT, with learning materials which, although not so fine-grained as in CALMAT, cover the topics and are mathematically sound. The questions and tests have been positioned within the module to provide the same pedagogical features as were available previously: formative assessment first, with individual questions close to the associated learning materials, then a mock test using a random selection of questions, followed by the summative test. This provides flexible, targeted feedback at the formative stage, with the only drawback being the lack of feedback for the summative test. However, it is possible for a tutor to reconstruct the question and feedback from the QTIWorks usage data. The new resources also have the additional benefits of being available online around the clock, and, from the staff point of view, having access to marks and full details of question parameter values to aid in individual tutoring.

### Motivation

Even with these improved resources, there is still a motivation problem. Some students question why they have to do Maths again, since they already have the qualifications for the course. We remind them that, as student Technology teachers, the reasons they study Mathematics are:

- To make sure that they really can do the Maths;
- And if they can do it, to help their classmates who can't;
- To improve their understanding of Maths and help them to join up the ideas;
- To provide them with a resource to refer to later in their course, and in their life as a teacher;

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- By combining these aspects, to make it easier for them to explain mathematical ideas to their pupils

In 2012-13, we introduced some social learning features to the module to try to address some of these needs.

### Social Tools

We added two Moodle forums to the course. The News forum was mostly used as a means for the tutor to announce new resources and course arrangements. The Topics Forum was used for students to request a "live" explanation of some topic in class, to report question bugs and to post questions about the questions and other resources. We would have liked to see some discussion between students, but suspect that this is a new concept to many, which may need some prompting from staff.

The module Wiki, intended to be a collection of student-authored additional resources, was under-used, partly, we suspect, because it was almost entirely empty when students went in, which was off-putting. However, one student did post a link to the site they had used during their Higher course, saying, "I found this really useful...". In fact, our students are not atypical in their reaction (or lack of reaction) to the wiki. There is a body of research which suggests that many students find the prospect of writing to a wiki particularly off-putting because of its hyper-interactivity although they may be confident in using IT in general (Cowan et al 2008, and see Honeychurch 2012 for a related point). The intention for next year is to partially populate the wiki to get students past the blank page problem.

The Mahara E-Portfolio was introduced as a record of learning and as a resource for reference later in the course, to remind students of the answer to "How do you...??" . A number of students have been using Mahara, but by its nature it is not easy to monitor. In subsequent years we intend to set aside class time for working in Mahara and the wiki, to ensure that students have the opportunity to benefit from these tools.

Although the tutor set up a Facebook group for the course, the class already had a group for their whole course for this year, and consequently did not engage with the additional group. In future, we intend to ensure that this module and its tutors are involved in the Facebook group, and to develop a page in Facebook to support the course.

### Observations and Conclusions

#### Content

The resources provided for learning Mathematics are more varied than before, providing in some cases several explanations of the same topic. This can be an advantage, but may prove confusing for some students. The assessment resources cover the topics as well as the CALMAT tests, and usually have improved feedback. They all have the great advantage of being available off campus, wherever students have a web connection.

From the staff point of view, it was efficient to reuse the questions, and the reporting mechanism was simpler than the CALMAT management system, and removed the need for handling another user name and password for each student.

The new course is developing a different emphasis from the previous version, moving away from doing Mathematics to applying it in the context of the course, and ultimately in the students' future careers. This is just beginning to become apparent in the conversations during class time.

### Usage

Students appear, from the small number of feedback questionnaires returned, to be happy with the self paced delivery of the course, and the new resources met with approval, although there was some dissatisfaction over the timing of the first tests. A wide range of completion times were again recorded for the redesigned course, although the rush to finish early was less pronounced.

Completing the tests only covers one aspect of the students' mathematical needs; the capability to detect errors in their own and others' working is still under developed, and more exercises in this area are needed.

In addition, these students need to practice using the mathematics they are learning, to ensure that they can explain the concepts they have learned; this can be achieved by incorporating some practical activities into the classroom.

Interaction between students during class time is rarely related to Maths, yet there is ample scope for the more capable to assist those who find it more difficult. We intend to split the class into groups next year and encourage group members to support each other in their learning both in class time and online.

It is also becoming apparent that many students forget their maths again after the first year, and find it hard to produce the most suitable mathematical techniques later in their course. Some further redesign of the content is likely, in view of this, and changes may be made to the content of the rest of the course.

### Further Development

We believe that the social tools that are included in this course can be beneficial to our students, but that more support is needed, especially initially, in order that students use all of them to their full potential. To address this, we are designing a range of classroom activities based on structured group work. We intend to devote some class time each week so that students can work in small groups to edit wikis, build their e-portfolios and author questions, and tutors will be on hand initially to ensure that the right group dynamics are set. We will also encourage higher achieving students to help their peers, as research shows that both the stronger and the weaker student improve when this model is used (Aronson, 1978; Honeychurch 2012).

The current tutor is working with colleagues on the BTechEd programme to ensure that the content of the module still aligns with the needs of the students in relation to the other modules in their course. It is likely that new topics will be included and some parts of the current topics may be removed from the course. Some topics which are currently amalgamated into one will be separated and expanded so that better coverage can be provided, for example for vectors and statistics.

A series of reflective, interactive and diagnostic activities is being developed, with the aim of improving the students' ability to select appropriate mathematical tools for their own use and explain to their pupils the reasons why they use them.

A user-friendly editor, Uniquarate<sup>1</sup>, which provides the means for authoring questions similar to those used within this module, is freely available, and students have been encouraged to use it to author their own questions on Mathematics and on other course-related topics. Uptake, however, has been minimal, and it is hoped that a more structured approach to using the editor and assessment delivery tools will lead to the production of a

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<sup>1</sup> Uniquarate, <http://uniquarate.kingston.ac.uk/Uniquarate/demo> (accessed 24/05/2013)



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useful collection of student-authored questions. Research shows that students who are expected to author questions, as well as to answer them, are more likely to develop advanced academic skills, and that student engagement will be higher if the benefits of this approach are explained to students at the outset; we will therefore ensure that we do this. (Bates and Galloway, 2013; Denny et al 2008).

Given the wide range of students' interests on this programme, we are also looking for further examples of quirky maths that will fire imaginations and improve engagement.

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