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# Encouraging student use of feedback, reflection and engagement through web-based learning support

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## Background and aim of the project

In this article, we describe an ongoing collaboration between the University of the West of England (UWE) and Mathematics in Education and Industry (MEI) to develop web-based learning support for students on mathematics-related courses at University. The collaboration started in 2004, with a grant from the Gatsby Charitable Foundation. This funding enabled web-based resources, originally developed by MEI for use by the Further Mathematics Network, to be reviewed, adapted and tailored (including new texts being written) to meet the needs of first year engineering students attending a traditional lecture course at University.

The aim of the project was to investigate student attitudes to the use of web-based learning support. The coursework component of assessment was conducted using on-line computer based tests, from which the students received immediate feedback as to their performance. Students were allowed multiple attempts at each test and so had the opportunity to use this feedback to improve their scores on a particular test. As a result of the work carried out in the project, students could choose to follow-up the feedback from their computer based tests using a variety of web-based materials, a text book or by seeing a tutor. They were free to use these resources in any way they chose. One of the questions we wished to address in the study was to see if students had a preference for a particular type of support and given the range of support available, was there evidence that students were effectively managing their own learning support (which obviously included going to see a tutor, if that is what they wished to do). A detailed description and evaluation of the project than that provided here was presented at the 5th IMA Conference on the Mathematical Education of Engineers [1]. A description of the use of computer based tests in engineering mathematics at UWE can be found in [2, 3]

The MEI web-based resources were of particular interest to UWE because the materials have been proven to work within a distance learning/support context. They were specifically designed to take students from a GCSE or AS-level background in mathematics to an A-level standard and beyond. At UWE there are two significant, not necessarily mutually exclusive, groups of students who require additional support at the start of their degree programme. These are students without A-level or AS-level Mathematics who are offering alternative entry qualifications that are considered to be equivalent, and students returning to education after a long break, possibly of more than four or five years duration. The MEI resources cover the topics contained within the first year 'Engineering Mathematics' module.

Typically students offering qualifications that are considered to be equivalent to A-level or AS-level Mathematics have completed a University foundation year, or have studied mathematics units as part of a National Diploma or a Higher National Certificate or an Access to Higher Education programme.

Taking the example of a student who has successfully completed a University foundation year.

*This student will typically have covered the A-level equivalent material within a single year starting from a GCSE or AS-level background. The foundation year will usually spend up to a third of the time available on mathematics, but will certainly select and give emphasis to topics for their direct relevance to a particular degree programme. When compared alongside an A-level Mathematics student, the foundation year student will have some gaps in their overall mathematical education and will have had a shorter period of time in which to consolidate their knowledge.*

However, our experience [4] and that of many other institutions is that Foundation Year programmes offer successful routes into Higher Education and that these students perform well in their studies. Such students are often older than their counterparts who entered university directly after studying A-levels (or equivalent qualifications). They are well motivated and work hard to overcome the difficulties that they encounter. Some of these students [are able to] use the experience of spending a year studying in a University environment to their advantage and start their undergraduate programme already having developed some useful independent study skills.

Similarly, mature students returning to study after a significant break often perform well, but are initially and understandably anxious about whether they will cope with the demands of a programme that requires a mathematical underpinning. These students may well feel they have difficulties keeping up with mathematics in their first year, even though they are often successful.

The aims of the collaborative project between UWE and MEI have been to see whether web-based learning resources offer an effective means of managing the diversity that is inherent within the population we have just described, together with students from traditional A-level academic backgrounds and to improve the student experience of studying mathematics at University. It should be noted that for our engineering programmes we have dispensed with diagnostic testing as way of identifying student weaknesses in mathematics. We have found in the past that diagnostic tests can reduce confidence in mathematics, even to the extent of leading students to drop out of their studies. By contrast, we have found that students from non-traditional academic backgrounds are often fully aware that they may have difficulties with the mathematics content of their degree and generally approach their tutors within the first week of their studies,

to find out what proactive steps they can take to remedy their situation or simply to gain reassurance that learning support is available should they need it.

We have therefore developed a system of student support which is

- offered to all students, embedded as part of the structure of their mathematics module, in a way that does not undermine the confidence of a particular group of students.
- structured in such a way as to promote student activity and engagement with their studies, so that confidence in the subject and the ability to cope with any difficulties are strengthened.
- flexible enough to cope with a diverse student population, not only in terms of academic background but also in terms of domestic and work commitments.
- makes use, as far as possible, of existing learning resources.

The first three requirements lead us towards a flexible delivery, with resources that are accessible off-campus, and therefore to web-based learning materials. The final requirement of using existing web-based resources, wherever possible, is important if we are to develop solutions that can be taken up by others. The MEI resources used in this project, and materials developed by the Helping Engineers Learn Mathematics (HELM) and **mathcentre** projects represent some hundreds of thousands of pounds worth of investment. These materials are generic in nature and the success of these resources within Higher Education will be judged on their application to a variety of different contexts.

Although the initial focus of this work has been on the mathematical education of first year undergraduate students attending lectures and tutorials, the materials used and the approach adopted could readily be adapted to other contexts such as supporting students from mathematics, science or economics degrees, pre-university transition support or a full distance learning delivery of a mathematics module.

### **The module delivery and learning support**

The approach adopted is to completely embed the learning support within the module. The key to the structure of the delivery is the assessment. The module is assessed by an end of module examination which must be passed, that is there is a minimum mark that has to be achieved, regardless of any performance on the coursework component of assessment. The module itself is divided into six learning units, namely: algebra, functions, differentiation, integration, differential equations and linear algebra. Students take a computer based test at the end of each learning unit. The coursework mark for the module is calculated as the average mark from these six tests. The tests are delivered over the web using QuestionMark,

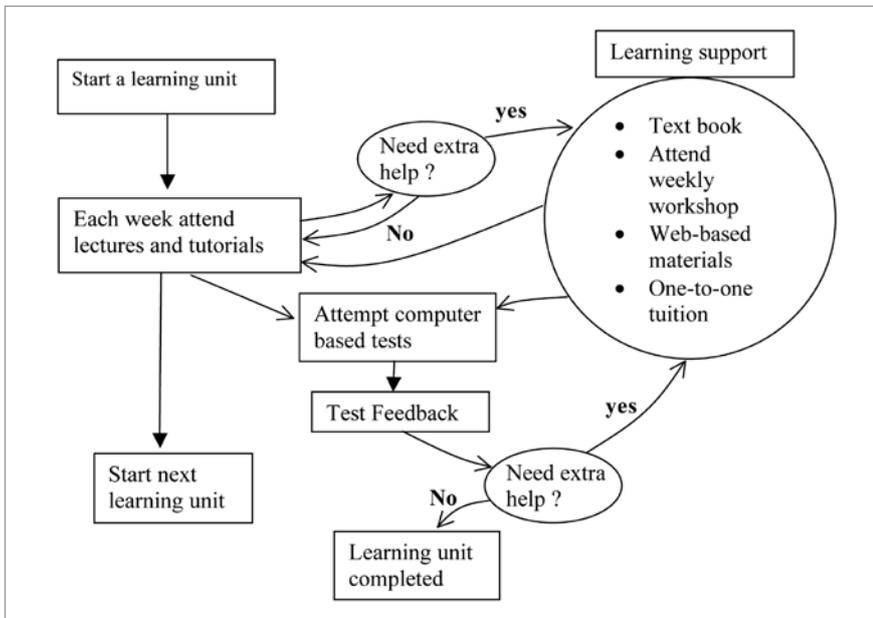


Fig 1 - Schematic diagram showing delivery and learning support for each individual learning unit

so that students can take the tests off-campus. Students are allowed three attempts at each test over a two week period, with the highest score counting. This testing regime immediately creates an element of self-paced learning in the module delivery, with students who may be having difficulties with the material able to see a tutor during the testing period or look at alternative learning resources. It means that, delivered in this way, the computer based tests contain both formative and summative elements for the student. Fig 1 gives a schematic view of how a student completes a particular learning unit.

As can be seen from the diagram, a variety of different forms of support are available, both web-based and those involving more traditional forms of support. Students access the MEI resources through a dedicated web-site for the module. The MEI resources consist of additional notes, worked solutions to the recommended textbook exercises, interactive resources (e.g. spreadsheets, PowerPoints and Flash) and formative assessments. The materials are presented so that they link to both the weekly delivery of the module and are cross referenced with the relevant pages from the recommended textbook for the module. Hence, while the web-based resources used in support of the module are generic, their use in the context of the module is tailored to the actual delivery. The structure depicted in the diagram permits an element of self-paced learning to take place, so that students who have fallen behind the pace of the module have a deadline (of two weeks) in which to catch-up with that particular learning unit. All students, regardless of academic background are given access to the same level of support, which is presented as part of the normal delivery of the module and not an additional activity only to be undertaken by weaker students.

One of the strengths of using computer based tests in the way described, linked to the availability of web-based resources is that we are able to create learning cycles within the module delivery involving reflective activity and students taking responsibility for their learning and achievement. This is very difficult to achieve with large numbers of students in a traditional module delivery based on paper-based assessment, chiefly due to the time it then takes to provide feedback to students. Our experience, since linking all of the different elements of the web-based assessment and support together, is that very few students take advantage of the one-to-one tuition available outside of timetabled class contact. It is

true that some students make use of their weekly group tutorials and others (although less than 10%) attend the workshops. However, tracking student use of the MEI module support web-site shows, as would be expected, a high use of the resources during the assessment periods.

In terms of staff time, the module delivery is fairly efficient. We have been using computer based tests for over eight years now, writing many ourselves and more recently using HELM materials wherever appropriate. The time transferred from marking scripts for between 150 to 180 students for multiple assignments has been more than sufficient to meet any costs we have incurred in providing weekly workshops and providing one-to-one support to students when required. Over the same period of time, we have seen our end of module results improve dramatically, so that we now generally expect a pass rate of 85% or above on the module.

### Student attitude and evaluation

From the student population on the module, it would have been expected that students would make greater use of the staff availability for one-to-one tuition or small group workshops. Our experience is that less than 10% of the cohort make regular use of the staff support that is offered in addition to the core module delivery. It may be that students find the weekly tutorials that follow the lectures provide sufficient support from academic staff. In fact, for the 2005-06 cohort, the lectures and tutorials were identified as the most effective learning resource, followed by the computer based assessments. However, the availability of one-to-one tuition was ranked as important, even by those who did not use this facility. Even though the computer based tests are part of the summative assessment for the module, it is the use of these same tests to provide feedback that was cited by students as being particularly useful. There was also evidence that students made use of both the text book and the web-resources in following-up

feedback from the computer based tests. So it seems that one of the outcomes of the study is the observation that in order to support a mixed and diverse student population, on this type of course, you require a variety of learning support strategies which can be delivered in a flexible way. That is, in a way that is flexible for the students to use and for the academic staff to manage.

In 2005-06, the MEI module support web-site was used by approximately 60% of the students. It is generally accepted that we are now educating an "internet" generation, who are used to accessing information via the web and who take for granted the convenient access to the information they require at a time they require it. Our work with students using web-based resources to support their learning would back-up this view up to a point, in that students certainly appreciate the ability to manage their own study time that the web-based assessments and learning resources allow. This is particularly true for mature students and part-time students who have more complex domestic and work demands on their time. It is not uncommon to have part-time students who are away from home, possibly abroad during the week, in between their day at the University. So it may be that, at the moment, the main benefits of web-based resources are to an older group of students who are not part of the "internet" generation!

Students' main motivation for using web-based resources was feedback from the computer based tests and, while this is not surprising, there is more work required to promote a more even usage of the resources from week to week.

Some student feedback about the resources is given below:

From a part-time student returning to study after a break of 13 years; she used the MEI web-based resources about once every three weeks, to help catch-up with worksheet questions and her view on the computer based tests as a method of assessment were that:

***"It ensures that you have understood the most recently taught unit and are able to revisit and discuss areas of weaknesses. Although the system is obviously open to abuse, it would not be in the long term interest of the student. This method of testing prevents me from feeling pressure and 'test' nerves. The main drawback is that the answers have to be accurate and that method marks cannot be awarded but this is compensated by the 3 attempts allowance."***

From a foundation year student. He used the MEI web-based materials once every two weeks, again to catch-up with worksheet questions, but also cited the web-based materials as his ***"preferred resource to address issues raised by feedback from computer based tests"***.

## Conclusions

The overall picture we have obtained from student evaluation of the support system we have created is that

students like to see a mixture of staff availability, web-based resources and a good text book. It seems that, in keeping with the culture of the day, students expect the availability of choice and freedom to organise their own time. This is perfectly reasonable, provided it can be positively linked to an active engagement in their studies. Our evidence so far suggests that the use of web-based resources alongside traditional class contact can promote student reflection and engagement with their studies.

We have used the expertise that MEI has gained through developing web-based resources for the Further Mathematics Network, to provide access to web-based resources to our engineering students in a form that they immediately recognise as being related to the material they encountered in class. It is imminently sensible, and often beneficial in terms of both time and preparation costs, to build upon material and projects that have already been created and 'evaluated'. Thus, tailoring material, from the vast array that are contained within MEI's resources, was an appropriate solution for UWE.

This year we have extended our use of web-based materials by adapting the MEI resources to support students on a distance learning engineering mathematics module. Students on this module are all part-time and hopefully the feedback from this module will help us to improve the way students at UWE use the web-based resources. In particular, we would like to promote more consistent use of the resources outside of the assessment periods.

For further information about this project or comments on the issues discussed, please contact **kevin.golden@uwe.ac.uk** or **stephen.lee@mei.org.uk**

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