

# Diagnostic Testing and Student Support

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## Abstract

*Students on Engineering awards at UWE come from a range of academic backgrounds that include A2/AS-Level, B-TEC, Foundation year, overseas qualifications and mature students who in some cases are returning to education after an absence of over ten years. Ensuring that individuals from such a diverse population can develop the necessary mathematical skills and knowledge to cope with the demands of an Engineering award is clearly difficult. In this case study we describe the development of diagnostic testing at UWE and its role in a strategy for teaching mathematics to a large mixed ability group.*

## The Execution

### A. Paper-based diagnostic tests (1992-97)

A paper-based multiple-choice test was designed to test basic knowledge of algebra, trigonometry and elementary calculus. The test was taken by students during induction week and was marked in time for results to be distributed during the first week of term. Students with substantial difficulty in a topic were referred to a Mathematics and Statistics Learning Centre for additional tutoring.

The system was inexpensive to set up and administer and provided feedback to both students and tutors together with a mechanism for acting on the information. Initially the system worked well but with each year the proportion of students demonstrating substantial weaknesses increased, until it became difficult to manage the follow-up support.

Student reaction to being tested at the beginning of the course was quite negative. The paper-based diagnostic test only offered students one attempt. Students did not have time to “prepare” for the test resulting in unease amongst some that they did not “do themselves justice” and by inference throwing some doubt over the usefulness of the information received. Many students did not participate in the remedial activity designed to address their real or perceived weaknesses. It was clear that in this format the diagnostic test did not necessarily give a realistic picture of an individual’s level of understanding and how they should subsequently organise their study.

Paper-based diagnostic testing was abandoned because it had ceased to make a positive contribution to the delivery of the module. In the period between the abandonment of the paper-based system and the introduction of computer-based diagnostic tests, a greater amount of time was given to the revision of basic techniques of algebraic manipulation, solving equations, trigonometry and calculus. In resource terms this was achieved by increasing the lecture time for each student from a single hour to two hours each week. Tutorials continued to be for one hour each week to a group of 20-24 students and resources given to the Mathematics and Statistics Learning Centre were increased so that it was staffed for one hour each day.

### B. Computer-based diagnostic tests

Diagnostic tests were re-introduced for first year engineering students at the beginning of this academic year. Students take four computer-based tests in algebra, equations, trigonometry and elementary calculus with three attempts at each test. Each test should take between thirty minutes to one hour to complete depending on the ability of the student. Students must complete the tests by the end of the second week of term and are given instant feedback as to their score. A different test (but of the same standard) is taken at each attempt. The diagnostic tests form the first stage of a support mechanism for the module which is summarised below.

The delivery of the module is as described in the previous section. Follow-up support to the diagnostic tests is initially managed through contact with students in tutorials. Students with significant problems are then offered one-to-one support by the tutor or through the Mathematics and Statistics Learning Centre. Material on the module is organised into four blocks with a computer-based test held at the end of each block (note that there is also an end of module examination). The test is open for two weeks and students are permitted three attempts. Having identified areas of difficulty, students can seek assistance during each test period from their tutor. After each test, workshops are held for students who still feel they require assistance with certain topics. Hence, students and tutors are being made aware at each stage where problems are occurring and the support offered can build upon the work already carried out by the student.

## Results

It is clearly too early to comment on the success or otherwise of the diagnostic tests in this course. However, some initial data is given below.

The average test scores for the four diagnostic tests are shown in table 1. The average scores for algebra and equations are much higher than the scores for trigonometry and calculus. This is not surprising as the calculus and trigonometry tests involve a higher level of manipulation than the algebra and equation tests.

The average scores for the first two computer-based assessments for the module are shown in table 2. The “Algebra and Functions Test” combines transposition of formulae, equations, trigonometric functions and other topics such as partial fractions and complex numbers that were not in any of the diagnostic tests.

**Table 1:** Diagnostic Test Statistics

Diagnostic Test	Mean (%)	Median (%)
Algebra	67	74
Equations	61	68
Trigonometry	34	30
Calculus	40	39

The “Calculus Test” consists of standard rules of differentiation and integration, including integration by parts and parametric differentiation, and again includes material beyond the level covered in the initial diagnostic test. The test scores suggest that the majority of students have either maintained or improved their level of performance since the beginning of the course. Clearly, we would have expected performance to improve once the course was underway.

One of the aims of the overall support developed for this module is to manage the different needs of the quite different groups taking the module. One of the benefits of the computer-based delivery of both the diagnostic tests and the assessment is that it creates a mechanism for monitoring the progress of students that is reasonably efficient in staff resources.

## The Barriers

### A. Student confidence and participation

Our experience of student reaction to computer-based assessment has consistently been positive. The system used is user friendly, very flexible and is intended to help students structure their study. The computer-based diagnostic tests were also well received by the students. In contrast to the paper-based tests used in previous years, students were much more willing to accept the rationale for the diagnostic testing. The multiple attempts meant that students felt that they were able to demonstrate their knowledge of the topics.

### B. Development cost

The computer-based diagnostic testing at UWE has been developed out of a Computer Assisted Assessment (CAA) programme that started in 1998 in the school of Mathematical Sciences. Hence, in this instance we were able to make use of a great deal of material that had already been developed and quality tested. Other material was imported from the *Mathletics* CD-ROM [1]. However, it should be noted that considerable staff time is required to set up the initial question bank.

### C. Technical issues

The CAA system adopted at UWE is QuestionMark Perception. While authoring and analysis of results is reasonably straightforward, there are issues to be considered of management of the question bank database and generating participant login names and passwords in an efficient manner, especially as the use of the system has increased. We currently assess of the order of 800 students using this system. Typically each student will sit between two and four tests with two or three attempts at each test. It is therefore essential to have good in house IT support.

**Table 2:** Assessment Test Statistics

Assessment Test	Mean (%)	Median (%)
Algebra and Functions	69	73
Calculus	64	68

## The Enablers

Computer-based assessment and diagnostic testing have been developed at UWE as a result of

- initial support provided by the Faculty for the development of the CAA programme
- colleagues within the school of Mathematical Sciences generating the majority of the questions
- use of freely available questions from resources such as *Mathletics*.
- dedicated technical support for managing the software and the question database.

## How Can Other Academics Reproduce This?

- Computer aided testing is expensive to set up in terms of staff effort. Some institutional support and leadership is required to free up staff time and to encourage sharing the workload among academic staff.
- The cost of development can be reduced by making use of existing resources and experience. In this respect, the LTSN is a useful body to provide relevant contacts.
- There must be an effective mechanism in place for acting on the information provided by the diagnostic test.

## Quality Assurance

As far as the tests are concerned, questions are internally moderated for both accuracy and standard. In addition to this, the results from the diagnostic tests are clearly of interest to other processes operating in the faculty such as admissions and student support. Apart from the support we have set up on the module, these wider connections have yet to be developed.

## Other Recommendations

- Prospective students could use the tests with revision material, to prepare themselves for their course prior to their arrival at the university.
- Diagnostic test results can be compared against material covered in specific A-Level modules to gain a more informed view of the potential strengths and weaknesses of students with a particular profile of A-Level results considered on a module by module basis.

### Reference

- [1] *Mathletics* CD-ROM, Greenhow, M., Brunel University.