Teaching Students with Diverse Backgrounds

A Learning Framework for Basic Mathematics and Statistics in Science

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Abstract

The teaching of mathematics and statistics forms part of a first year module, Scientific Inquiry, which is taken by students on undergraduate science courses. The range of mathematical backgrounds amongst the students is accommodated through a Virtual Learning Environment (VLE), supporting student-centred learning. The Case Study describes the philosophy of the module and how this is reflected in its structure, delivery, available materials and use of self-assessment.

Level of Material: First Year

The Execution

The core philosophy of the module design is that the learning provision should include:

- A clear demonstration of what the student is expected to achieve.
- Opportunities, within a credit-bearing context, for regular self-assessment of capabilities.
- A study programme which is appropriate for a range of entry skill levels.
- Study support materials available on-line through a VLE and the internet.
- Lectures to introduce new material and provide general guidance.
- Computer supported tutorials for demonstrations and individual support.

Students sit a paper-based, but computer-marked, diagnostic test (40 questions) during the Induction Week. The results, together with answers and interpretation, are returned to the students within the first teaching week. The aim is to introduce the idea of structure within the learning programme, and stress the importance of self-awareness in the learning process.

There are 24 teaching weeks, each with one full class lecture (80 students), smaller group tutorial session (12 students) of one hour and the availability of a 'drop-in' help session.

Each week normally addresses one study unit. Each study unit is divided into Fundamentals, Amplification and Study Notes. Currently this material is provided as 'hard-copy' and is also available through the VLE. The answers to questions are normally only available through the VLE to encourage wider engagement with the material.

The Fundamentals section includes basic questions in a progressive study sequence, together with key 'theory' statements and essential equations. This section is useful as a 'revision' programme for students who have met the material before, but it also provides the framework for the topic introduction in the lecture.

The Amplification section includes computer-based skills (mainly using EXCEL) that the student needs to master in the tutorials and/or further questions and applications relating to the topic. The Study Notes provide a more traditional 'text-book' coverage of the topic.

Summative assessment of the module includes two computer-based tests for mathematical and statistical skills and two portfolios of various tasks. The portfolio tasks include analysis of experimental results, writing a report following an information search and recording of performance in relation to the learning objectives. A modelling assignment using EXCEL also provides a combination of challenges that integrates the mathematical, statistical and IT sections of the course.

Self-assessment tests are provided through the VLE after five and ten weeks in each of the two semesters. The fact that the students take the test contributes to their module mark (through their progress record within the portfolio) but their actual score on the tests does not.

Pre-requisite Knowledge

The minimum entry requirement for all programmes taking this module, is Grade C in GCSE or equivalent in mathematics. In practice, a number of students have recently passed at A2 in GCE Mathematics and/or Statistics, but for a significant proportion, their mathematics background is mainly Grade C in GCSE taken at least two years previously.

This particular module is aimed at first year science students. Level of study for this particular module is first year science students. However, a second year module extends study in both statistics and experiment design, with VLE support material for both years.

How Are Students With Different Mathematical Backgrounds Supported?

The diversity of previous experience was the major consideration in the design of materials and approach. One aspect of the strategy uses the Fundamentals sections which

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- Makes learning objectives very explicit (through example problems) – allowing students to focus their own learning requirements.
- Presents essential facts and equations – allowing 'experienced' students to confirm or revise their knowledge, and highlighting stepping stones for 'new' students.

Another aspect is to encourage student-centred learning through the provision of constructive feedback with an Induction Test and four Self-Assessment tests, worked examples and VLE support available on and off campus. Sufficient tutorial time was also available for struggling students to seek help – but see 'Barriers'.

What Support Was Needed?

No special training is required. The delivery of tutorials in MS EXCEL uses computer laboratories equipped with data projection facilities for class demonstrations. Minitab is also used to a limited extent as it is already available on the system, but it is not essential.

The Barriers

The two greatest barriers are the diversity of student backgrounds, and the fact that many first year science students find it hard to develop interest in, and motivation for, mathematics and statistics.

The delivery structure (see 'Different Backgrounds') has relieved many of the 'diversity' problems. The 'interest and motivation' problem now becomes the next major issue. Lecture style, together with the use of relevant examples, appears to be very significant in addressing group attitudes. However, there still remains a small but difficult group of, usually weaker, students, whose lack of motivation and interest means that they still fail to engage fully with the available opportunities.

The Enablers

The most important enabler is the student-centred structure and mix of learning provisions:- hardcopy notes and questions supported by VLE software and self-assessment, together with lectures and tutorials.

The use of the Fundamentals sections as the focus for lectures has led to more a positive reaction from the students as well as a greater sense of student engagement.

Evidence of Success

Feedback from students through questionnaires and informal discussions shows that they are generally happy with the teaching style, and that each of the different aspects of learning provision are useful to significant subgroups within the total cohort. Performance records also show that students with limited mathematics experience can do well on the module.

How Can Other Academics Reproduce This?

This form of teaching is mainly applicable to topics where it is possible to define learning outcomes in some detail, hence its use for first year support mathematics and statistics. It is important that the structure of the learning resources is very clear to the students, that the style of the 'lecture' integrates with this structure and is not a stand-alone 'traditional' lecture.

The application of the mathematics and statistics to support different disciplines would require some restructuring of materials, particularly in respect of topics chosen and examples used.

Quality Assurance

Module curriculum, assessment details and teaching methods form part of the Module Specification, which must be approved through the Quality Assurance system in the university. Student representatives report to regular Programme Management meetings and students provide written feedback at the end of the module.

Other Recommendations

The fact that the staff both have backgrounds in science appears to be helpful in developing an approach which is sympathetic to the science students' perceptions of mathematics and statistics.

Current developments include identifying key self-assessment questions that students should be capable of answering before starting each new study unit – important for progression in topics such as statistics and algebra.

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