

Microbiologists and maths

Ron Bishop & Adrian Eley

Most microbiology students are scared of maths. Ron Bishop and Adrian Eley share some resources and strategies developed to combat those fears and give confidence to the innumerate.

● Biologists, of course, are traditionally hopeless at maths, but nowadays the term 'hopeless' seems to have acquired new depth of meaning. Why are so many of today's microbiology students, at least in the UK, so completely incapable of handling numbers properly? Almost every microbiology tutor, usually no great shakes mathematically themselves, despairs at student attempts to manipulate data and understand quantitative concepts. A recent symposium of the Society's Education Group (*Developing Mathematical Skills in Microbiologists* at Exeter last September) explored the problem.

● Scared of maths

Why are we so scared of maths? Roseanne Benn, of the Institute of Lifelong Learning at the University of Exeter, has studied the attitudes and experiences of English adults. She has shown that people in general can and do cope quite well with numbers (betting, numerical and logical quizzes, money), but only by abandoning 'school maths' and developing their own roundabout methods. It's not maths *per se* but formal 'school maths' that is really the problem for most people, including many graduates. She has outlined a long series of very convincing reasons why there is a cycle of aversion between teachers and learners and why formal maths teaching in primary and secondary school is perceived by most of its victims as being authoritarian and not intrinsic to real life situations.

● Maths help

Clearly, microbiology students are coming into tertiary education sharing many of these attitudes. Tutors find that they need to spend large amounts of time repetitively going over very basic points with individual students, and discussion throughout the symposium reinforced the benefit of as nearly as possible one-to-one remedial tutorials. But the days are long since gone when we could find the time or resources to do this routinely. Money helps, though, as was impressively shown by Helen Robert of the University of North London. UNL is institutionally a strong supporter of the 'capability curriculum' concept and is prepared to devote some institutional funding to non-specialist maths and numeracy support. Helen and her colleagues in the School of Communications Technology & Mathematical Sciences, advised by a university-wide Maths Group, developed 'Data analysis' and 'Maths through IT' modules that are taken by a very wide range of beginning students. Crucially, a central maths workshop, staffed for 10 hours per week by two very experienced, patient and approach-

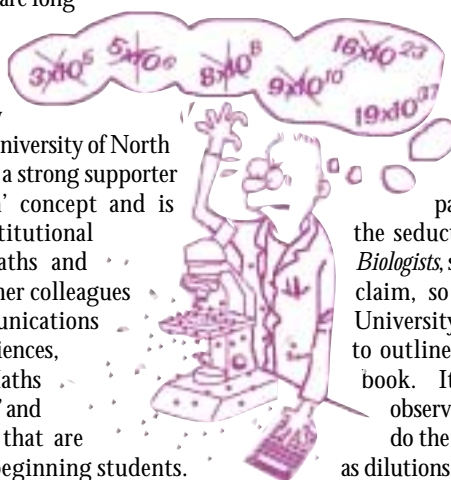
able further education teachers, and with purpose-built facilities, is available to support the students. The workshops are extensively advertised during module classes and provide a wide range of both web- and text-based materials in addition to the personal and group contact. Diagnostic tests mapped onto a learning grid help students to identify their particular problems and banks of data taken from Honours projects and other sources provide learning examples that are directly relevant to each student's specialism. Extensive web-based delivery allows student progress to be monitored more easily and also allows them to support each other through on-line discussion groups.

● Numeracy package

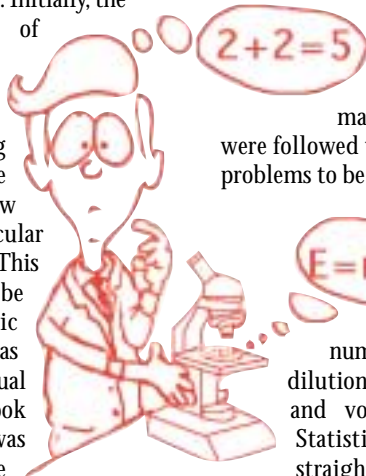
Several microbiologists around the country have started their own initiatives. Kay Hack of the School of Biomedical Sciences, University of Ulster, was able to get funding to develop a complete numeracy package for entry-level students. It is CAL-based to facilitate independent learning and to build in assessment. A diagnostic section identifies strengths and weaknesses and can plot changes in skill level throughout the student's career. A wide range of colleagues was surveyed to define the mathematical skills that are really needed by life sciences students and these are developed in the on-line tutorial sections, again linking the exercises to course and module content by using subject-specific examples. The content of the package can easily be changed for different student groups and modified in the light of experience. The database allows comparisons between student groups or institutions as well as customization of information for the students and their advisers. Interestingly, it suggests that new postgraduate students may be even less numerate than first year undergraduates – perhaps their tutors have learned to avoid the numerical stuff in later parts of the courses!

● Workbook

Traditionally, we would have told students with a maths problem to get a good book and work through it. Indeed, there are several on the market aimed particularly at biologists. One, with the seductive title of *Easy Mathematics for Biologists*, seemed in particular to live up to its claim, so its author, Peter Foster of the University of Central Lancashire, was asked to outline the origins and rationale of the book. It started from the common observation that students were unable to do the very simplest of calculations, such as dilutions or concentrations. Concerned staff in the Biological Sciences Department at Central Lancashire tried to develop a skills module including



numeracy to improve students' ability to do simple calculations and to interpret graphs. Initially, the conventional module structure of lectures and worked examples proved largely ineffective as students differed so much in their abilities and speed of understanding that the pace suited nobody. The approach was altered to allow students to identify their particular deficiencies with a diagnostic test. This mostly showed the difficulties to be in applying their existing basic mathematical knowledge (which was usually, if not always, there) to actual practical problems. A workbook of eight sequential sections was developed, covering procedures like ratios, exponentials, expressions and graphs that are basic to all biologists. First the concept is introduced, followed by worked 'pure' examples and then worked applications. Students study at their own pace but with an hour a week of small(ish) group tutorial contact with staff. Various forms of assessment have been used, all showing most students to make significant improvements. The workbook was published commercially in 1998.



assignments by 95% so that the effort can be redirected to individual student support.

His presentation outlined the implementation of hands-on computer sessions and how lectures describing mathematical and statistical techniques were followed with a URL providing a set of relevant problems to be completed and submitted over the web for computer-marking. Problem clinics were open to all, but were compulsory for those who failed or did not submit the problem answers. The numeracy syllabus covers concentrations and dilutions, units, indices and exponentials, areas and volumes and manipulating numbers. Statistics and IT syllabuses are also very straightforward and relevant, and all the applications covered in the latter are used directly to carry out and submit the coursework. Much of the staff-student communication is by email. The results and student feedback, both positive and negative, from the first running of the module are shown on the website. The first cycle of module redesign in the light of this feedback includes abandonment of the peer support mechanism which seemed ineffective, enhanced feedback emphasizing methods of calculation rather than just the correct answer and some modification of the problem clinics. There are still some uncertainties, though; not least of how to motivate and reward the high achievers who found it all too easy!

So do not despair! There are still no simple or perfect answers to the thorny problem of developing mathematical skills in our students. But these and several other microbiologists (e.g. Alastair Wardlaw at Glasgow University and Vicky Tariq at Queen's University Belfast) have worked very hard to develop good practice and the rest of us can learn a great deal that is useful from their achievements. As Alan Cann's well known motto says, 'Education costs money – ignorance costs more'!

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Further reading

Benn, R.C. (1997). *Adults Count Too*. London: National Institute for Adult & Continuing Education.

Foster, P.C. (1998). *Easy Mathematics for Biologists*. London: Harwood Academic Publishers.

Useful websites

<http://www.unl.ac.uk/ctms/mathshelp/>

<http://www.ulst.ac.uk/resources/numeracy>

<http://www-micro.msb.le.ac.uk/AJC/talks.html>

● The internet

The internet is often seen by those who haven't really tried to use it as the answer to all pedagogical problems. Inevitably, it isn't; but it can certainly help and students feel increasingly comfortable with it. No-one who searches the web for microbiology education resources gets far without coming across material from Alan Cann of the Department of Microbiology and Immunology at the University of Leicester. Alan's PowerPoint presentation is on his website. It describes the development of a web-based first year numeracy module at Leicester. Since the 1960s, staff had tried to promote relevant numeracy skills in a first year 'Quantitative Biology' course, but the evidence suggested it remained of little value to the students despite its many modifications. In 1999, in accord with the university's Learning and Teaching Strategy, a new module 'Numeracy and computer skills for biologists' was developed. It aims to promote not only subject-specific and transferable knowledge and understanding, but also student planning skills and time management through the use of continuous assessment and electronic submission of assignments. The underlying ideas are to fuse the acquisition of numeracy and IT skills by computer-based delivery and assessment of both topics via the web, to use computer-based learning to overcome biologists' traditional negativity towards maths and to reduce staff time spent on repetitive marking of weekly

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