

Adapting mathtutor for the Life Sciences

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ABSTRACT

The growing concern amongst life science disciplines and professions about undergraduates' mathematical competencies has been well documented over recent years. This paper provides the background to and summarises a pilot project which aims to adopt technologies used in the production of *mathtutor* in the development of a multimedia, e-learning resource to deliver mathematics support for students of the life sciences.

mathtutor is a new mathematics e-learning resource for mathematics and science education, which delivers diagnostic tests, video tutorials, interactive exercises, animations and printable text via DVD and the Internet. A team of academics is currently working in collaboration with the EBS Trust to adapt aspects of *mathtutor* for life science undergraduates. We plan to adopt a contextual learning model in our creation of a problem-solving e-learning environment. Our aim is to develop a selection of case studies and scenarios, presenting each in a highly visual manner and enabling students to explore and practise the mathematics within each. The principle of this approach is that the context (i.e. the case study) motivates students to *want* (in addition to *need*) to learn the maths. Each case study will have associated with it a series of questions, tasks and calculations for students to complete. Students will also be provided with video-based tutorial support (similar to that adopted in *mathtutor*) for those maths topics and concepts with which they lack confidence or with which they are unfamiliar. There will also be the opportunity for students to practise and apply their skills to new case studies, thus linking theory to practice.

INTRODUCTION

During the past 10 years many life science disciplines and professions have grown increasingly concerned about undergraduates' (and now postgraduates') mathematical competencies, particularly as these disciplines have become increasingly quantitative, requiring greater levels of mathematical confidence and higher standards of skills and competencies. Unfortunately, many have witnessed a concomitant decline in the more basic mathematical skills of students embarking upon undergraduate life science programmes and their observations and concerns have been well documented [1-7]. The 'maths gap', which first manifested itself with students entering undergraduate programmes in engineering, mathematics and the physical sciences, is now only too apparent in a range of other disciplines, including the biosciences and health sciences. The concerns shared by all these disciplines have resulted in collaborative projects and initiatives that have yielded a wealth of good practice regarding mathematics support, much of it, for obvious reasons, emanating from the traditionally more quantitative and mathematical disciplines. Universities have attempted to address the challenges presented by this 'maths gap' by adopting a variety of strategies aimed at supporting students, both within and outside their primary curricula. This paper focuses on one particular development, i.e. *mathtutor*, and outlines how the technologies it adopts are being adapted for the life sciences.

mathtutor has been developed by a consortium of UK universities working in collaboration with the Educational Broadcasting Services Trust (EBST), and represents a package of interactive multimedia e-learning resources, designed to support post-GSCE mathematics, particularly at AS and A2 levels. *mathtutor* supports self-directed learning, applying a tutorial model of teaching, and makes extensive use of 'live' tutor videos and animations. Diagnostic tests enable students to assess their own skills and level of understanding with regard to individual maths topics, while interactive exercises provide the opportunity for students to further practise the mathematical skills they develop. When the pilot 'Algebra' disk was evaluated in 2003, over 80% of students in more than forty schools and colleges across Britain reacted favourably towards *mathtutor*; they liked the

method of teaching and learning it adopted and found the diversity of learning resources it provided useful.

ADAPTING V. ADOPTING EXISTING MATHS RESOURCES

A quite legitimate question would be 'Why *adapt mathtutor*? Why not use existing strategies and resources to support maths in the life sciences?' Before answering this question it is perhaps worth highlighting that many higher education life science departments have already implemented a range of strategies directed at trying to address the 'maths gap'. These range from modifying their existing undergraduate curricula to accommodate maths teaching (supported by their own staff or by mathematicians), to using a variety of text-based and computer-based learning resources, facilitating peer-assisted learning [8], and encouraging students to actively participate in additional institution-wide mathematics support initiatives (e.g. maths support centres). However, where life science undergraduates are concerned, many of these initiatives have met with limited success – for several reasons.

Firstly, there is often a limit to how much of the life science curriculum academics are prepared to 'sacrifice' to address what they perceive to be the more basic mathematical skills problems which are not of their making, but rather due to deficiencies in secondary level maths education (particularly, but not exclusively at GCSE level). Pressures to increase (or even maintain) student numbers mean that making AS- or A2-level Maths a compulsory entrance requirement for many undergraduate programmes is probably unrealistic.

Secondly, the quality of mathematics-support teaching in HE, whether undertaken by life science academics themselves or by mathematicians (as part of internal 'service teaching' contracts) can vary considerably, and may even decline in the future due to shortages of maths specialists. For some in the life sciences, teaching maths is not a priority and/or of their choosing; many believe their time would be better spent either teaching 'bioscience' or engaging in their research activities; while mathematicians, although having the best of intentions, may be unable to convey the relevance of the maths by presenting it in context, resulting in student disinterest.

Thirdly, most existing materials and resources (multimedia and text-based) have either been designed to support primarily mathematics, engineering and the physical sciences (e.g. *mathtutor*), and/or they deliver mathematics for the biosciences by 'tagging on' biological examples to a traditional model of maths teaching – consequently they fail to adopt a learning approach that is 'bioscience student-centred' and may do little to counteract the very real anxieties many life science students feel towards anything mathematical. Since many school-leavers with a strong interest in the sciences elect to study the biosciences in the false belief that they can avoid anything too mathematical, building their confidence in maths and getting them to recognise at an early stage in their undergraduate programmes just how important maths is in helping them understand many biological phenomena is half the battle. The other half of the battle involves extending their maths knowledge and further developing their maths skills.

Whilst many in the life sciences may be aware of *mathtutor* and may have used elements of it where they feel it appropriate, some highlight the limitations of its structure for bioscience students. A fresh approach to the problem is required with the development of new materials, designed specifically for bioscience students.

The EBST's considerable expertise in designing and producing high quality multimedia learning resources, which stems from their many years' experience of developing distance learning materials, ensures that their production methods result in a quality of teaching that is both consistent across institutions and of a higher standard than can be achieved in many classroom situations, particularly in higher education. The use of such high quality multimedia learning resources, alongside existing bioscience curricula, has the potential to enhance teaching and to accelerate learning; students may be able to grasp mathematical concepts more quickly and then practise and apply their knowledge in new contexts and to fresh problems. This mathematics learning can then be reinforced by bioscientists within their own particular element of the bioscience curriculum and within specific contexts.

CONTEXTUAL MATHS SUPPORT FOR THE LIFE SCIENCES

A team of bioscience and maths academics, representing universities from across the UK, is currently working in collaboration with the EBST to adapt aspects of *mathtutor* to provide learning support for life science undergraduates, as well as for students studying Biology or Human Biology at AS and A2-levels. We plan to adopt Coles' contextual learning model [9, 10] in our development of a video-led, multimedia enquiry-/problem-based e-learning environment (Fig. 1). Our aim is to develop a selection of bioscience case studies and scenarios, presenting each in a highly visual manner and enabling students to explore and practise the mathematics within each. The principle of this approach is that the context (presented via the case study/scenario) should motivate students to *want* (in addition to *need*) to learn the maths. Each case study will have associated with it a series of questions, tasks and calculations for students to complete. Students will also be provided with video-based tutorial support (similar to that adopted in *mathtutor*) for those maths topics and concepts with which they lack confidence or with which they are unfamiliar. There will also be the opportunity for students to practise and apply their skills to new case studies, thus linking theory to practice.

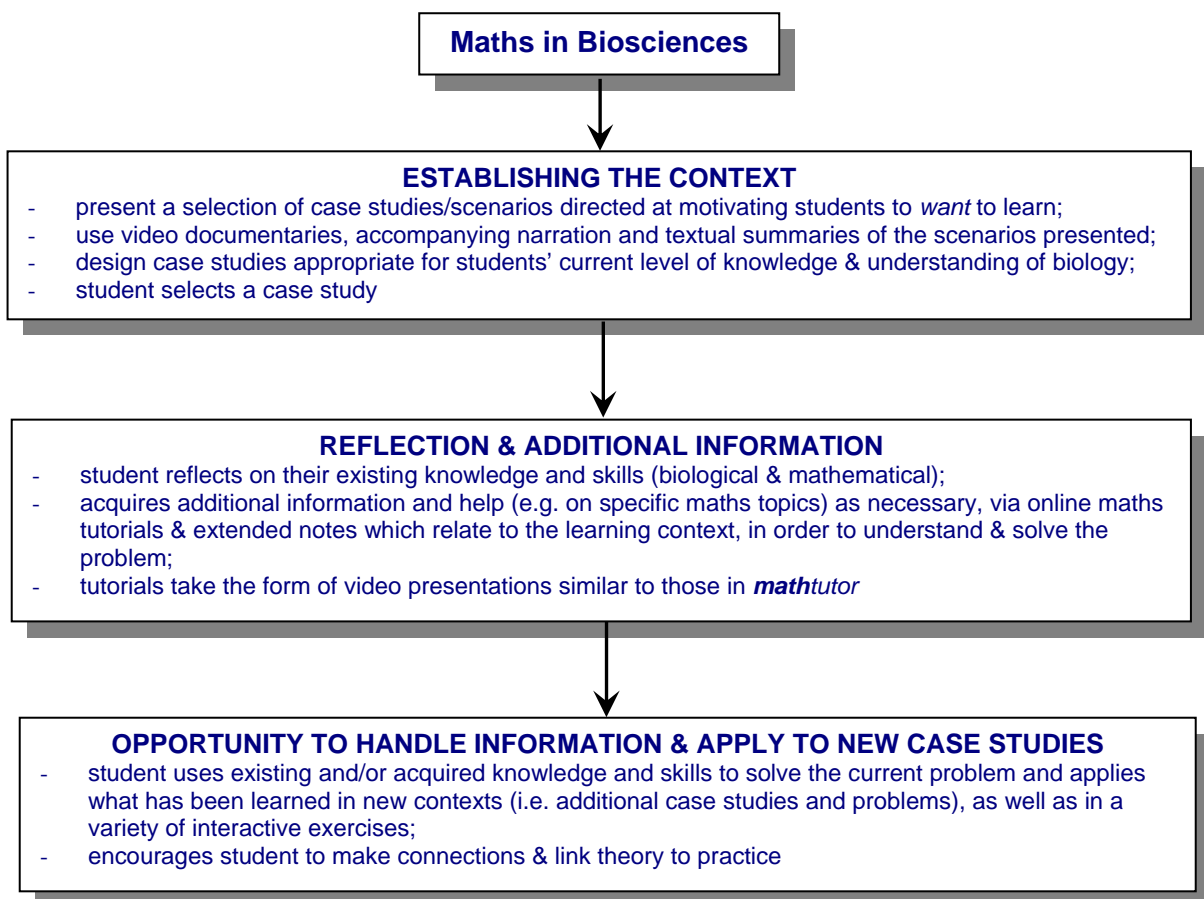


Figure 1 Contextual learning model for a multimedia e-learning resource to support mathematics in the life sciences

'MATHS IN BIOSCIENCES' PILOT PROJECT

A pilot project currently underway has three primary aims:

1. to develop learning resources for post-16 students in schools, FE colleges and universities, which will support mathematics education specifically within the biosciences. The learning resources will be delivered via DVD and a dedicated web site;

Specific objectives:

- to produce two filmed bioscience case studies which will set in context a series of problem-solving questions;
- to prepare a textual description of each case study which will provide additional details and background information;
- to prepare a series of diagnostic tests which will enable students to assess their pre-knowledge of specific maths topics associated with the case studies;
- to produce eight video tutorials to support specific maths topics associated with the case studies;
- to prepare a series of exercises to enable students to practise the mathematical skills and apply the knowledge they have acquired in the context of the biosciences.

NB The production of a single case study and its associated learning resources (as described above) is currently being funded by HEFCE through its National Teaching Fellowship Scheme.

2. to identify and evaluate strategies aimed at motivating both students and their tutors to use the learning resources effectively in supporting bioscience curricula, and identifying and addressing potential barriers to their widespread use at secondary, further and higher levels of education;

Specific objectives:

- to evaluate bioscience students' and their tutors' reactions to the learning resources developed;
- to assist bioscience tutors in formulating strategies for the integration of the learning resources into the learning environment, whether that be in timetabled formal teaching sessions (practical classes) or in private study (e.g. at home);
- to identify and evaluate strategies aimed at motivating students to use the learning resources, e.g. developing associated formative and summative assessment strategies or linking to peer-assisted learning. All students will be working towards a post-16 qualification in bioscience and therefore should have some inherent motivation to use the learning resources developed;
- to identify and address potential barriers to the widespread use of the learning resources at secondary, further and higher levels of education and implications for policy and practice.

3. to evaluate the impact of the learning resources on the mathematical competence of bioscience students and their ability to transfer their problem-solving skills and maths learning to fresh biological contexts.

Specific objectives:

- to evaluate the impact of the learning resources on the mathematical competence of bioscience students at different levels (e.g. post-GCSE, post-AS, post-A2 levels) and possessing different prior experiences of mathematics education;
- to evaluate the transferability of the students' mathematical skills, by testing the students' ability to transfer their mathematical skills to new biological problem-solving contexts.

For the purpose of this pilot we are setting the mathematics in the context of bioscience curricula at AS, A2 and first-year undergraduate levels. In doing so, we aim to motivate students to want to learn the maths inherent in the biosciences. The 'template' we are developing will provide a model for applied mathematics in many disciplines. The learning materials developed and their presentation using DVD and the Internet will support independent and/or tutor-facilitated learning and should be appropriate for students aged 16+ years, who exhibit a diversity of learning styles and strategies, studying within a school, college, university or home environment.

Upon completion of this pilot project, we should be in a position to apply for a significant level of additional funding (from one or more sources) to produce a far more extensive learning resource based around a much larger number of case studies, covering a diversity of life science disciplines.

It is perhaps worth emphasising that since our concept and ideas apply multimedia technology and expertise already in place as a result of the production of *mathtutor* (and the earlier *Maths for Engineers*) by the EBST, we are not 'starting from scratch', but rather adapting and extending a tried and tested formula.

There is widespread support for the production of materials which address the specific concerns of the life sciences, from the perspective of students and their tutors. We have already won the support of many colleagues from across the higher education sector and are confident that more will join our ranks as our work and its dissemination progress. We are keen to involve as many bioscientists and mathematicians as possible in the actual design and development processes. If you are interested in participating in this initiative please contact Vicki Tariq (vtariq@uclan.ac.uk) or Jim Stevenson (jim@ebst.co.uk).

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