School to University Transition: a university teacher's perspective

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Lucy Cavendish College
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Division of labour

UNIVERSITY OF CAMBRIDGE

lectures, practicals, exams

Lucy Cavendish College
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tutorial support:
academic, pastoral

This is a personal perspective from a teacher experienced in lectures and tutorials for science, medical and vet students for past 6 years…

I lecture for the University of Cambridge and provide continuing professional development for the pharmaceutical industry through my own business Science ETC (www.sci-etc.co.uk). I provide tutorials for several Cambridge Colleges but am employed by Lucy Cavendish College.

Lucy Cavendish College is a college for mature (over 21) women students and takes students from a very wide range of backgrounds. All must satisfy the demanding entry requirements for Cambridge.

What is maths education for at first year university level?

(1) basic toolkit of mathematical techniques needed for the least quantitative of the biological sciences.

(2) sufficient maths to understand and participate in research in systems biology and computational biology

How many typical biology graduates would have sufficient maths for (2)?

First year maths courses at Cambridge

***Elementary Maths for Biologists* requires GCSE maths**

algebra, trigonometry, logarithms, differentiation, integration, statistics, frequency analysis, use of Excel

This course provides a tool-kit – the bare essentials
Future course choice limited to straight biology subjects (not systems or computational biology).

Numbers taking this course have reduced in recent years as more students take A level Maths.

First year maths courses at Cambridge

***Mathematical Biology* requires A2 maths**

growth and decline of populations; physiological modelling, statistical methods, multivariate data analysis and ecological and epidemiological modelling.

Further calculus and grounding in mathematical modelling
Course choice can include 4th year course in systems biology but not second year chemistry.

Taken by the majority of biological natural sciences students.

First year maths courses at Cambridge

***Mathematics A* requires A2 maths**

algebra and calculus of both scalar and vector functions, ordinary and partial differential equations, Fourier series, matrices, complex numbers, probability.

This course is required for those who intend to continue with Chemistry and Physics and is taken by only a small number of biological natural sciences students.

What are the issues?
What are the potential solutions?

transition from…

GCSE

AS

A2

Access to HE

others eg Open University

transition from…

GCSE

$$y = \frac{3\cancel{x}+1}{4\cancel{x}}$$ **?!**

-algebra is very weak

-cannot reliably rearrange simple equations

-have no idea what logs are

-cannot manipulate scientific notation without a calculator

$$\frac{6nmol}{2\mu l} = \frac{6\times10^{-9}\,mol}{2\times10^{-6}\,l} = ?$$

-unfamiliar/unconfident with using units, especially non-standard ones

Specific learning difficulties

It's worth thinking about the impact of specific learning difficulties on:

- algebra
- scientific notation

Sometimes these are diagnosed at end of first year at uni.

Disrupted education can particulary impact on maths as the subject is so hierarchical.

transition from AS, A2…

at the lower end of the spectrum:

- good at reproducing exam answers but lack of depth of understanding
- some unconfident with algebra, logs, exponentials, graphs, simple calculus
- attitude to importance/relevance of maths in biology and willingness to work at it
- gap year → very rusty
- unfamiliar/unconfident with using units and prefixes

transition from AS, A2…

at the upper end of the spectrum:

- extremely confident!
- difficulty in using appropriate words to describe the maths results, setting out problems logically
- relating the maths to the biology

transition from Access to HE

very difficult to find any information about what is covered in these courses in any detail

the design of Access to HE courses:

- two out of chemistry, physics, biology
- a little bit of maths, similar to GCSE

common transition issues

If I don't understand one bit of the lecture how I am supposed to follow the rest of it? I'm used to being able to ask questions straight away.

The accelerated pace.

Pace of lectures compared to lessons.

Volume and intensity of work.

** comments from the Transkills Project, University of Cambridge*

common transition issues

- Expectations of university teaching staff are at odds with what students can do and have done.

  - There are things we take for granted: eg “M” for molar concentrations instead of “$mol.dm^{-3}$”
  - Setting out answers and showing working, using sentences to describe what they are doing and why.
  - Solving more open-ended problems

- It is well accepted now that the level of mathematical skill has declined but this is not always understood by university teaching staff.

"The decline in the level of mathematical skill displayed by students upon entry to universities in the United Kingdom has been well documented in numerous learned society, professional body and research reports"
Pell and Croft, Teaching Mathematics and its Applications Vol 27, No. 4, 2008

PISA (Programme for student international assessment): Its latest table, which covered 57 countries, shows that the **UK has plummeted from 8th to 24th in maths**
http://www.timesonline.co.uk/tol/life_and_style/education/article5467255.ece

With thanks to Steve Hewson, NRICH Project

common transition issues

- Being able to translate the biology problem into the maths – picking out the relevant numbers in a problem and to ignore numbers that aren't relevant
- Ability to estimate the answer and recognise if the answer is a long way out

being able to think hard, not expecting to be able to solve it immediately

- Students often assume that they are alone in finding it hard
- Some need reassurance that it's OK not to have completed every question on the sheet.
- You learn from attempting a question, even if you don't solve it until you receive some hints. Some students find this hard to take on board.
- … develop strategies for what to do when you have no idea how to start a question.

** comments from the Transkills Project, University of Cambridge*

some solutions?

- Problem: difficulties in adjusting to university-style learning eg lectures vs lessons, open-ended problems, not completing problems.
  - pre-course eg PREP course helps to manage expectations
  - (further info see http://www.admin.cam.ac.uk/news/dp/2008100904)
  - online transition materials – the Transkills Project
  - (for further info see http://www.skills.cam.ac.uk/undergrads/transkills/)

some solutions?

- Problem: Expectations of university teaching staff are at odds with what students can do and have done.
  - educate staff! change courses!
  - educate students!
    - AS maths as entry requirement (!?)
    - bridging courses??
    - online materials

online materials

nrich

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This month: Stage 1&2 | Stage 2&3 | Stage 3&4 | Stage 4&5

bioNRICH

Problem | Teachers' Notes | Printable page |

Stage: 4 and 5 Challenge Level: ★

stemNRICH : Science, Technology, Engineering, Mathematics *enriched*

Welcome to **bioNRICH**: the biology section of stemNRICH. This contains mathematical activities for students aged 14 - 19 designed to complement and enhance the study of biology.

bioNRICH

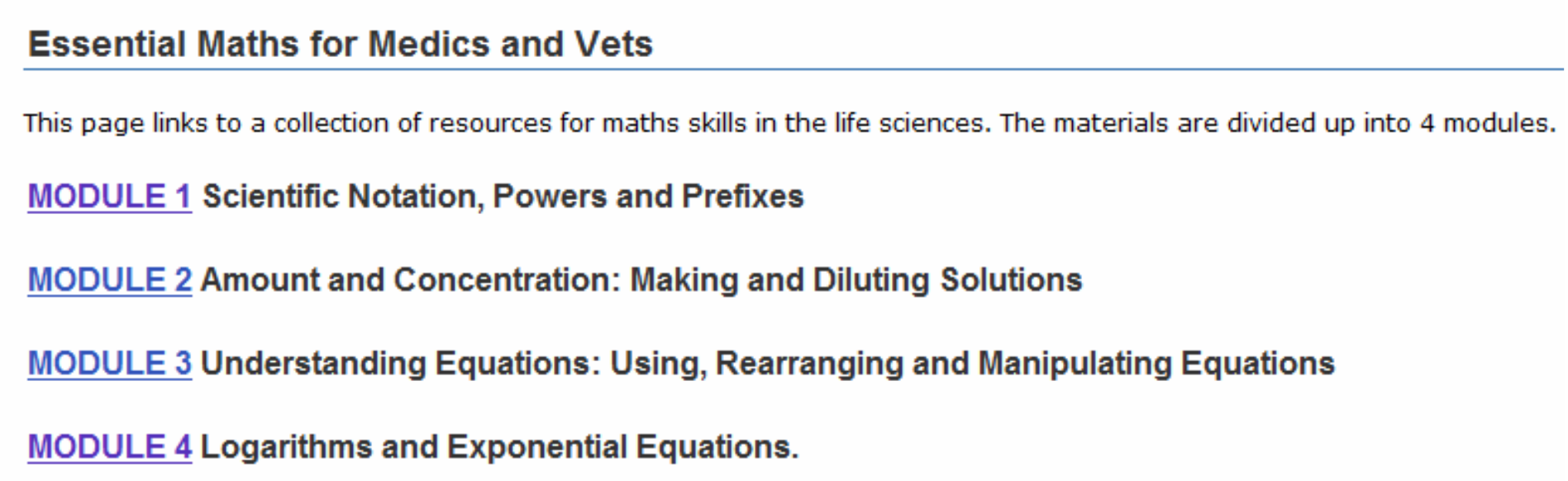
- bioNRICH is a part of the NRICH website devoted to the application of mathematics to biology.
- It is for teachers and students with an interest in science
- The applications were chosen first; the maths questions were designed around these.

- http://nrich.maths.org/stemnrich

“Essential Maths”

maths questions in a biological context

audiovisual explanations and practice questions



Essential Maths for Medics and Vets

This page links to a collection of resources for maths skills in the life sciences. The materials are divided up into 4 modules.

MODULE 1 **Scientific Notation, Powers and Prefixes**

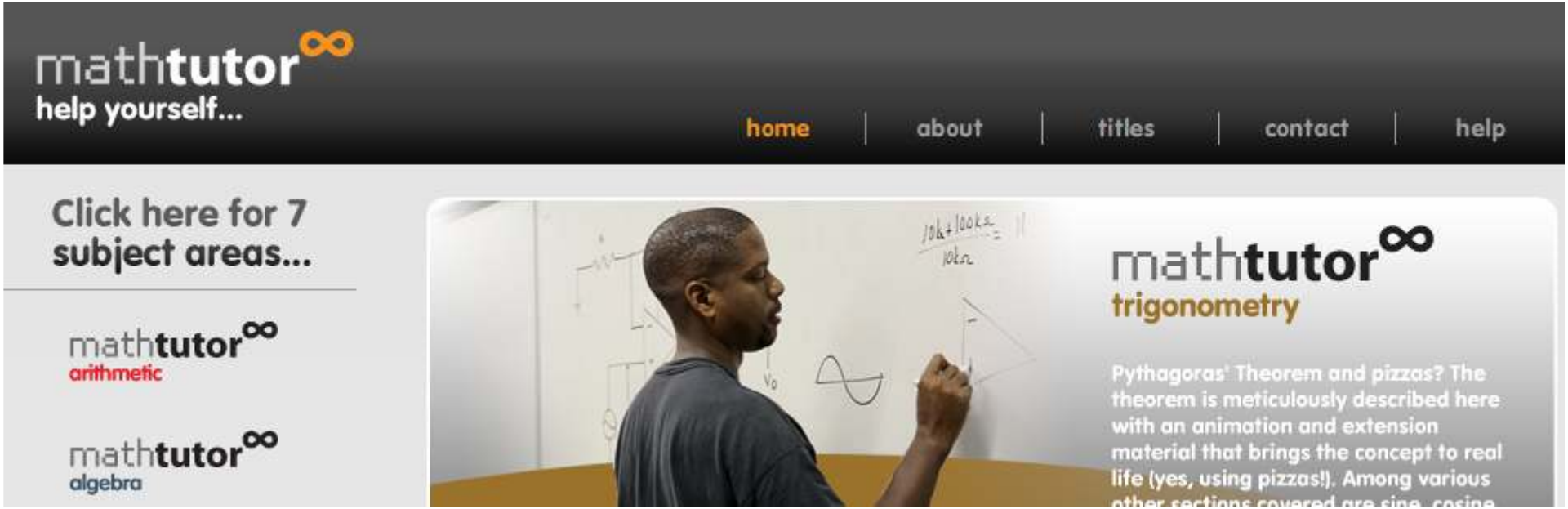
MODULE 2 **Amount and Concentration: Making and Diluting Solutions**

MODULE 3 **Understanding Equations: Using, Rearranging and Manipulating Equations**

MODULE 4 **Logarithms and Exponential Equations.**

http://tinyurl.com/5djzn7

MathTutor



http://www.mathtutor.ac.uk/

lots of resources…

- fragmented, sometimes hard to find
- will students actually use them?? when??
- site stats suggest they are used in Christmas and Easter vacations.

Mathematics Is Biology's Next Microscope, Only Better;

Joel E Cohen

Those who understand the calculus, ordinary and partial differential equations, and probability theory have a way of seeing and understanding the world, including the biological world, that is unavailable to those who do not.

PLoS Biol. 2004 December; 2(12): e439.

JE Cohen, PLoS Biol. 2004 December; 2(12): e439 quoting

[CUBE] Committee on Undergraduate Biology Education to Prepare Research Scientists for the 21st Century,

National Research Council of the National Academies, 2003.

“Educating the next generation of scientists will require early emphasis on quantitative skills in primary and secondary schools and more opportunities for training in both biology and mathematics at undergraduate, graduate, and postdoctoral levels.”