Teach Mathematical Modelling (and not Mathematics) to Life Scientists

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Who Am I?

- RCUK Research Fellow working in the fields of Mathematical Biology and Systems Biology.

- Background in Mathematics and Physics with a PhD in Applied Mathematics.

- Current post is a joint appointment between Mathematics and Biological Sciences at the University of Reading.

- 12 years experience (including PhD time) researching at the Mathematical Modelling Life Science interface at the Universities of Southampton, Oxford and Reading.

- Experience over the last 5 years of teaching mathematical modelling to life scientists and industrialists through MSc courses, short courses and supervision of MPhil and short PhD projects (more on this later).

Mathematics vs Mathematical Modelling

Mathematics

- Consists of learning mathematical concepts and ideas, e.g. algebraic manipulation, trigonometric functions, graph sketching, etc.

- Advantages: Teaches life scientists quantitative skills.

- Disadvantages: Students can see as `dry’ and boring. Difficult to motivate learning because concepts can often be quite abstract.

Mathematical Modelling

- Consists of the process of developing and formulating a mathematical model of a real world process or system.

- Advantages: Students learn to think about the “system” they are focusing on, the process of formulating a model to describe, learning to solve the model and use the results to inform questions asked about the system being modelled.

- Disadvantages: ... ?

“Typical” Mathematical Training

- Primary school – Counting, basic number manipulation (e.g. addition, division, etc.), solving simple problems (e.g. If X has three cans and gives 2 to Y, etc.), graphing, introduction of simple algebra, basic trigonometry (e.g. Angle concept).

- High school – Trigonometry, algebraic equations and manipulation, simultaneous equations, differentiation, integration, complex numbers, basic mechanics, basic differential equations.

- University (Yrs 1 & 2) – “Toolbox of mathematics”: Analysis, formalisation of theorems and proofs, calculus (more advanced integration methods, differentiation of more complex functions), linear differential equations, basic numerical analysis, discrete mathematics. Distinction is made between Pure and Applied Mathematics.

- University (Yrs 3 & 4) – More advanced topics and applications to a wide range: Numerical methods, asymptotic analysis, advanced analysis, stochastic theory, financial mathematics, fluid dynamics, dynamical systems theory, introductory mechanics of solids, mathematical biology and more ...

“Typical” Mathematical Training

And finally ...

- University (PhD) – In Applied Mathematics one learns the “trade” of applying mathematics to real world problems, i.e. specific areas of mathematical modelling.

And the Life Scientist?

- Teaching mathematical modelling which has been used to show insight into life science problems (biological and/or biomedical) teaches the advantages of learning it.

- Students do not need to learn difficult mathematical concepts.

- They can appreciate the use of mathematical modelling in helping to solve *their* problem(s)/question(s) just like any other tool at their disposal.

- Students can be motivated to learn more complex mathematics by actually seeing its applications and benefits.

- Mathematical training in reverse???

- 3 Brief case studies.

In Conclusion

- Good examples of mathematical modelling used to understand and/or answer problems in the life sciences can be used to motivate students that **mathematics** is an important tool for assisting them with their work.

- How far can we push this ...?

- Currently developing a programme at Reading which integrates mathematical modelling and basic mathematical concepts into a Systems Biology course for 3rd and 4th year biological science students.

- Finally, its important to remember that mathematics teaches **a way of thinking** which is highly advantageous in tackling questions/problems in the life sciences.