Teaching the core concept of gradient flow: application of Mathbench modules

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One of the core principles of Physiology is gradient flow, which is fundamental to many physiological processes (Michael *et al.*, 2009). Developing an understanding from first principles is crucial towards comprehension of diffusion and osmosis, and hence nerve conduction and kidney function for example. Many students in the biosciences lack sufficient mathematical skills and confidence and this impedes their ability to understand formulae, analyse data, and reason correctly to draw meaningful conclusions. Students typically struggle with understanding how the flow of ions across the cell membrane through protein channels, affects the membrane potential. In order to address this issue we have implemented the use of Mathbench, a series of interactive online modules covering many fundamental areas of biology, first developed in the US by Thompson and colleagues (Thompson *et al.*, 2010). These modules allow students to visualise the mathematics in an engaging and easy to understand manner. Asmembers of an OLT funded project, we have extensively revised and adapted a large number of the modules for use in Australian universities. The modules within the "Cellular Processes" subsection of Mathbench cover the topics of diffusion (Fick's first and second laws), diffusion through a membrane, osmosis and the Nernst equation. The Nernst equation module was trialled with first year Biomedical students at Monash University, and first and second year Human Physiology students at Griffith University. Students were asked to voluntarily enrol in the project at the beginning of semester, and given pre- and post-surveys and tests. Preliminary results on the implementation indicate that students enjoy the modules and find them useful. The pre- and post-tests contained 10 questions concerning ion distributions across the membrane and resulting membrane potential. Student performance based on pre- and post-test results improved, from an average of 5 out of 10, to 8.7 out of 10, however this improvement was not able to be attributed to the use of Mathbench *per se*. Only about 30% of students took full advantage of this online resource, thus it would appear that the best way to implement Mathbench is to make it a compulsory activity.

Michael J, Modell H, McFarland J, & Cliff W. (2009). The "core principles" of physiology: what should students understand? *Adv Physiol Educ* **33**, 10-16.

Thompson KV, Nelson KC, Marbach-Ad G, Keller M, & Fagan WF. (2010). Online interactive teaching modules enhance quantitative proficiency of introductory biology students. *CBE-Life Sci Educ* **9**, 277-283.