



## The use of blended learning to teach metabolism

**J.O. Macaulay** and **M.P. Van Damme**, Department of Biochemistry and Molecular Biology,  
**K.Z. Walker** Nutrition and Dietetic Unit, Department of Medicine,  
Monash University  
janet.macaulay@med.monash.edu.au marie-paule.vandamme@med.monash.edu.au  
karen.walker@med.monash.edu.au

### Introduction and Aims

We have developed a blended program for teaching Biochemistry, in particular metabolism, to undergraduate students undertaking the degrees of Bachelor of Science, Biomedical Science and Nutrition and Dietetics. In these degrees, where graduates develop scientific skills and clinical skills when appropriate, a thorough understanding of biochemistry is essential.

Blended learning approaches aim to bring together face to face and online learning modalities in combinations which will enhance student learning ('Blended learning' 2005; Aycock, Garnham and Kaleta 2002; Garnham and Kaleta 2002). Our aim in designing blended biochemistry units was to integrate the various components of the units into single continuous entities with the components being linked and interdependent. We therefore developed an integrated blend (Clark 2003) delivered both online (*WebCT-Vista*) and offline (face to face lectures and tutorials, distributable print media, CDs). A range of interactive multimedia learning modalities and face to face learning exposures are thus used to promote interactive, active, student-centred learning and enhance students' problem-solving skills. Blended learning was introduced to:

1. cater for a range of learning styles and engage students at a higher level of learning;
2. integrate in-class and out-of-class learning;
3. improve students' ability to master and integrate biochemical concepts which are fundamental to understanding metabolism;
4. allow students to work at their own time and pace using online learning; and
5. encourage students to assess their knowledge and understanding through electronic quizzes and to provide prompt and direct feedback on their performance.

### Content of the Blended Courses

The teaching/learning packages encompass the following:

1. Lectures (face to face) with extensive lecture notes available online (*WebCT Vista*)
2. Self-directed learning which encompasses tutorials and problem solving exercises that are presented as online and offline computer activities and paper-based exercises
3. Tutorials with and without tutors
4. Case studies presented in a variety of formats:
  - face to face discussion/tutorial sessions.
  - online followed by tutorials.
  - entirely online with accompanying learning material and quizzes online.
5. Self assessment quizzes (online).
6. Analysis of scientific papers and websites (online and paper based).
7. Laboratory based practicals and research projects.

### Lectures

Face-to-face lectures are an integral component of our units as we feel they contribute to the students learning (Bligh 2000). In many cases the lectures emanate from case studies, are attuned to problem solving and aim to be less didactic and more student-centred to encourage deeper learning (Biggs



1993; Ramsden 1992). Lecture notes are accessible online (as Power point presentations on *WebCT-Vista*).

### **Self-Directed Learning**

The self-directed activities integrated in these units allow students flexibility of pace, time and place of learning. Examples of self-directed activities blended into our units include in depth tutorials to enhance students' understanding of metabolism compiled in two CD-ROMs, *Biochemistry- A Metabolic Challenge* and *Nutritional and Hormonal Aspects of Diabetes*. Students can access these tutorials either on CD-ROM or on campus (Monash University server). *Biochemistry- A Metabolic Challenge* is based on a series of highly interactive tutorials covering various aspects of metabolism. *Nutritional and Hormonal Aspects of Diabetes* incorporates three main menus: 'Introduction to Nutrition', 'Biochemistry of Diabetes' and 'Dietary Therapy for Type 2 Diabetes'. These programs use animated demonstrations, 'click and drag' reaction sequences, and varied assessment formats (Multiple Choice Questions, 'click and drag' the correct answer, True/False statement). Students receive either immediate feedback or are directed to find appropriate answers for themselves.

Problem solving exercises have been developed (included in both CD-ROMs) to enhance students' analytical skills and to help them learn to integrate material from varied sources. Examples are; 'The great metabolic race' which describes catabolic metabolism associated with long distance running and 'The after race banquet' which discusses anabolic processes associated with the recovery phase after a meal. These exercises lead to interactive activities e.g., 'Inter-relationship between pathways after a meal, between meals and during starvation', an exercise that enables students to understand how the body's metabolism differs in the 'fed' or 'fasted' state. This activity leads students, step by step, to analyse the effect of starvation on the metabolism of macromolecules. Inter-relationships between pathways in various tissues in fed or fasted states are also compared to, and contrasted with, the effect of type 1 and type 2 diabetes on tissue metabolism.

### **Tutorials**

Tutorials play a major role in integrating a range of teaching/learning components into single continuous entities in which the components are linked and interdependent. We use traditional tutorials, with tutors, as discussion forums to extend and reinforce material presented in lectures, web-based cases and self-directed learning exercises. Tutor-less tutorials are a modification of self-directed learning in which students work independently in small groups at assigned times. Students are divided into syndicates, allocated scenarios with accompanying questions and required to prepare 'mini posters' which they present to the class, in the presence of a tutor, at the end of the session. An example of this is 'Metabolism in health and disease'

### **Case studies**

A major teaching/learning component of these blended units is the extensive use of case studies. Details provided in each case may include: patient history, physical examination and results of blood tests. The cases, timed to integrate with the lecture program, aim to revise and extend students' knowledge and help students integrate their learning. A range of modalities have been incorporated into the application of the case studies including:

1. Entirely face to face discussion/tutorial sessions: case details provided to students during tutorials.
2. Web-based combined with face to face tutorials: students access the case online and prepare responses before a face-to-face tutorial. After the tutorial, detailed discussion is posted online allowing for student revision and exam preparation. In addition, self-review multiple choice questions relating to the case and to the review material are also posted for student self-assessment.
3. Entirely web-based: case details and accompanying interactive activities and quizzes are either online or on CD. Feedback and model answers are provided after submission of answers online. If students perform poorly, they are directed to relevant course material for further study.



The following are examples of topics covered in case studies in a range of units.

- Effects of alcohol on metabolism
- Gout caused by an enzyme deficiency in purine metabolism
- Anaemia and red blood cell metabolism
- Congenital adrenal hyperplasia (error of steroid hormone synthesis)
- Pernicious anaemia caused by vitamin B12 deficiency
- Type 1 diabetes and Type 2 diabetes

### **Self-assessment quizzes**

Quizzes related to lectures, cases and problem solving exercises are posted for students on *WebCT Vista*. These allow for both formative and summative assessment and revision before exams. They comprise both multiple choice and short answer questions. Feedback and model answers are provided after students have submitted their answers online.

### **Analysis of scientific papers and websites**

The aim of these exercises is to provide students with an understanding of how research papers are written, the peer review process and how to think critically about research data and to be able to evaluate web sites. To analyse scientific articles students are provided with edited sections (introduction, methods and results only) of scientific papers from peer reviewed journals and are required to discuss the papers without the aid of abstracts, discussion and conclusion sections. Web analysis involves students visiting designated websites and assessing them for: accuracy, authority, objectivity, currency and coverage (Alexander and Tate 1996).

### **Laboratory based practicals and research projects**

The units integrate varying numbers of laboratory practicals ranging from enzyme kinetics to the analysis of diet records and assessment of nitrogen balance.

### **Evaluation**

Discussions with students and responses from questionnaires have indicated that the students have responded particularly well to the participatory nature (active learning) of these blended units. Many students commented that the case studies (on- and off-line) were critical to the units as they enabled them to focus on the relevance of biochemistry. The computer based case studies were reported as very enjoyable learning experiences, which encouraged self-directed learning and gave students confidence and satisfaction in their own ability as well as the opportunity for more flexible learning. Some students however, indicated the importance of accompanying tutorials with access to the expertise of a lecturer/tutor and for many learners this may be an important aspect. The range of responses illustrates the varied learning styles used by students. Students found the online quizzes to be a valuable tool which gave them the opportunity to test their performance and understanding of the content through MCQs/SAQs and feedback comments. The quizzes also reinforced which concepts were important to understand.

### **Discussion and Conclusions**

We all have preferred learning styles (Kolb 1984) but also use a range of different learning methods. The multiple modalities for learning that blended learning/teaching provide has the potential to cater for the different learning styles of our students. The units we have developed were designed to build on this potential of matching the learning needs of the students to different delivery methods and integrate in-class and out-of-class learning. The incorporation of an integrated blend of components should assist students to apply their knowledge gained and master and integrate biochemical concepts which are fundamental to understanding metabolism and to appreciate the relevance of biochemistry, thus motivating knowledge acquisition and deepening the quality of their learning.



### Acknowledgements

The authors wish to thank Monash University, the Faculty of Medicine, Health Sciences and Nursing and the Department of Biochemistry and Molecular Biology for financial support. The authors are grateful for the input of all colleagues who have been involved in the development of the programs.

### References

- Alexander, J. and Tate, M. (1996) *Web resource evaluation techniques*. {Online} Available: [http://www.widener.edu/Tools\\_Resources/Libraries/Wolfgram\\_Memorial\\_Library/Evaluate\\_Web\\_Pages/659](http://www.widener.edu/Tools_Resources/Libraries/Wolfgram_Memorial_Library/Evaluate_Web_Pages/659).
- Aycock, A., Garnham, C. and Kaleta, R. (2002) *Lessons learned from the hybrid course project*. Teaching with technology, **8**. [Online] Available: <http://www.uwsa.edu/ttt/articles/garnham2.htm> [2005, June 29]. Blended learning [Online] (2005) Available: <http://commons.ucalgary.ca/blendedlearning/index.html> [2005, June 29].
- Bligh, D.A. (2000) *What's the use of lectures?* 2<sup>nd</sup> Ed San Francisco: Jossey-Bass.
- Biggs, J.B. (1993) From theory to practice: a cognitive systems approach. *Higher Education Research and Development*, **12**, 73-85.
- Briefing: The opportunity of blended learning. [Online] Available: <http://www.cohere.ca/briefing.html> [2005, June 29].
- Clark, D. (2003) *Blended learning*. [Online] Available: [http://www.epic.co.uk/content/resources/white\\_papers/blended.htm](http://www.epic.co.uk/content/resources/white_papers/blended.htm) [2005, June 29].
- Garnham, C and Kaleta, R. (2002) *Introduction to hybrid courses*. Teaching with technology, **8**. [Online] Available: <http://www.uwsa.edu/ttt/articles/garnham.htm> [2005, June 29].
- Kolb, D.A. (1984) *Experiential Learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.
- Ramsden, P. (1992) *Learning to teach in higher education*. London: Routledge.

© 2005 J.O. Macaulay, M.P. Van Damme, and K.Z. Walker.

The author(s) assign to UniServe Science and educational non-profit institutions a non-exclusive licence to use this document for personal use and in courses of instruction provided that the article is used in full and this copyright statement is reproduced. The author(s) also grant a non-exclusive licence to UniServe Science to publish this document on the Web (prime sites and mirrors) and in printed form within the UniServe Science 2005 Conference proceedings. Any other usage is prohibited without express permission of the author(s). UniServe Science reserved the right to undertake editorial changes in regard to formatting, length of paper and consistency.