Engaging students in clinical bacteriology: a fresh look

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Frequently there is a disconnectedness, either perceived or actual, between theoretical principles and laboratory practice in science education and this holds true for clinical microbiology where traditionally knowledge is delivered in 'chunks' in a lecture format with the misguided belief that students have to know 'everything about everything'. This preoccupation with content delivery often leaves no time for active class discussion or reflection. Moreover, laboratory classes are treated as add-ons to the process, rather than an integrated part of the whole learning experience. In redesigning our units (subjects) we have bridged the gap between the theory and practice of clinical bacteriology. In doing so, we have seen a transformation in the learning experiences of our students and in the way we teach.

In studying clinical bacteriology, a student's key learning outcome should not be acquisition of knowledge in isolation, but also concept understanding and application. According to Handelsman *et al.* [1]:

> *most science is taught as lectures that are dominated by facts rather than principles and ways of thinking … and yet … substantial evidence shows that lecturing alone is a relatively ineffective way of teaching and retention from lectures is poor.*

Ramsden and Watson [2] state that:

> *good teaching encourages high-quality student learning … and energetically encourages engagement with subject content.*

We argue that while content is important (that is to say, learners must have a solid knowledge base underpinning their understanding and application), graduate attributes such as critical thinking (CT) and complex reasoning (CR) skills should also be developed and refined as part of a broader and integrated learning process. Graduate attributes of CT and creativity sought by prospective employers are not easily achieved through passive observation of subject content [3]. CT-CR skills are important for capstone students if they are to successfully transition into professional clinical practice, industry or research where such skills are not only valued, but an integral part of daily work practices [T Jennings, personal communication]. Often in the workplace, graduates undergo retraining because they lack the requisite generic attributes and higher order skills which diagnostic microbiology laboratories require and value.

> *As a manager of a private medical microbiology laboratory the reality is that I want a recent graduate that can assimilate into a laboratory environment readily and be trained in as short a time as possible … clinical laboratories will require microbiologists that consider the 'big picture' rather than just processing the specimen or cultures in front of them. It is the role of tertiary educators to produce graduates that have an understanding of the basic techniques employed in clinical laboratories, an overview of current relevant methodologies in routine use and the ability to collate the clinical information with the culture results to generate an interpretation that is clinically relevant.* [T Jennings, personal communication].

In targeting these attributes, we should also ensure that our students connect in a way that they are informed, engaged and even entertained. Consequently, we are striving for an evolution in our classrooms from passive information acquisition (knowledge delivery) to active learning experiences (knowledge construction) (Figure 1).

Our traditional didactic lecture formats have been replaced with a lecture-tutorial hybrid (or lectorial). The first part of the lectorial involves either a role-playing exercise or simulated patient presentation (in the form of case scenarios). These are then dissected in an interactive question and answer (Q&A) session addressing in turn each of the steps in the infectious disease diagnosis (IDD) pathway: patient presentation, empirical diagnosis, patient management (empirical), investigation

requested, specimen management, diagnostic laboratory processing, patient management (review) and follow-up.

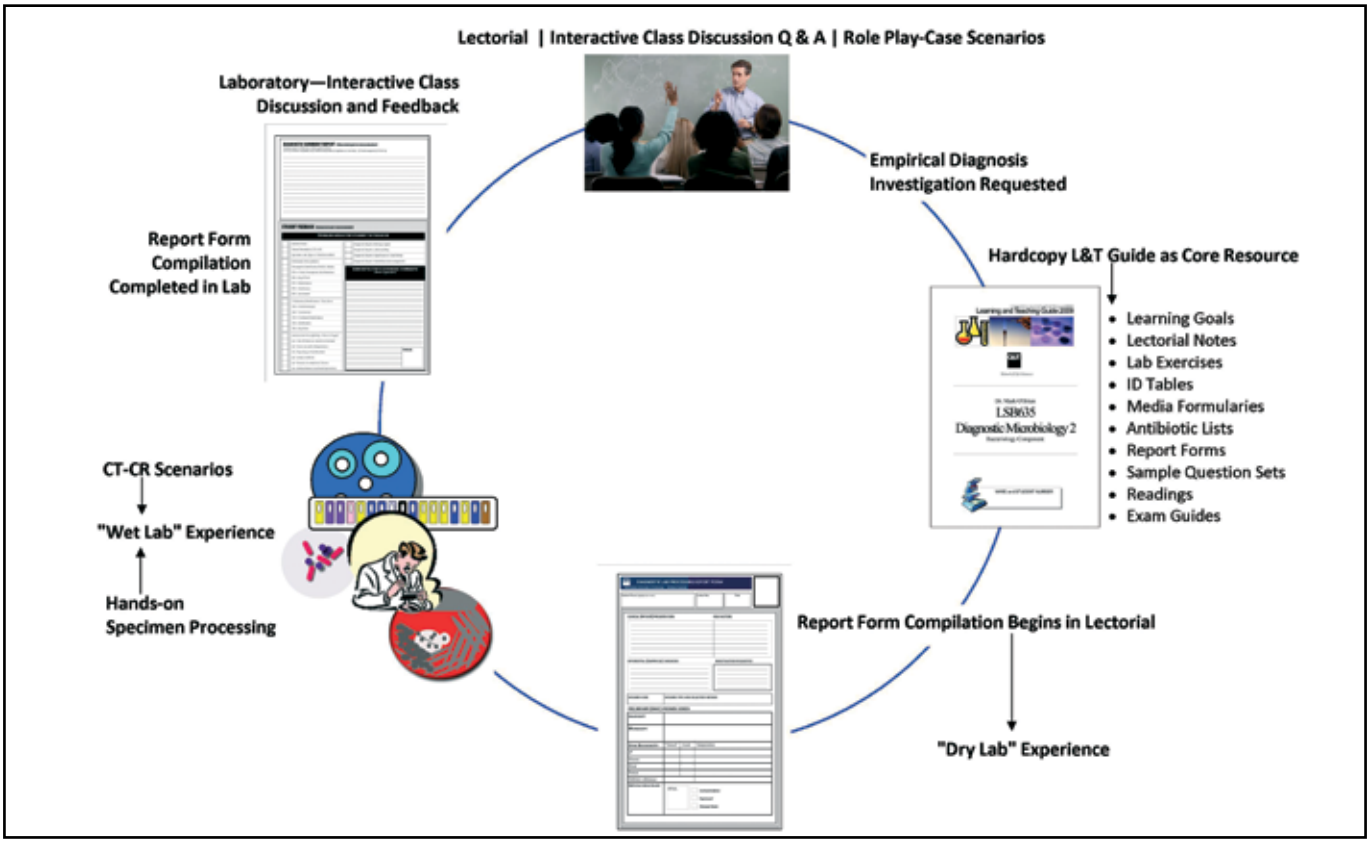
Role play involves students asking questions of the lecturer as a 'patient' suffering with an infectious disease related to the lectorial topic and is followed with a question like: "You have worked out the likely disease state, potential aetiological agents and relevant specimen – where to from here?" Students are actively encouraged to ask and answer questions and to use their CT-CR skills in the lectorial. With each new case scenario, concepts common to the IDD pathway are revisited as a way of knowledge scaffolding, together with an emphasis on critical knowledge points and the development and refinement of concept understanding. Frequently, the starting point for this constructive learning is the student's general knowledge or own life experiences, based on friends or relatives who have contracted an infectious disease, or their background reading or even their studies in other subjects.

A core element of the teaching and learning integration is the *Learning and Teaching Guide* – a hard copy resource organised into chapters according to bacterial disease states. Each self-contained chapter comprises lectorial key notes, laboratory exercises laid out in descriptive detail, recommended readings and sample questions (multiple-choice questions and short answer). These questions are intended to provide formative assessment and evaluate both knowledge and CT-CR aspects, thereby promoting independent student learning. Factual data such as isolation media formulary, bacterial identification tests and ID tables, antibiotic lists and report forms are also included as appendices. It is a 'living document', with students adding their own notes, reflections and additional hard copy resource material collected during the semester. The *Learning and Teaching Guide* replaces (and improves upon) the typical 'lab manual' format.

Whilst many courses in diagnostic microbiology focus on specimen analysis, our approach is a holistic one, discussing what happens before the specimen gets to the pathology laboratory as well as afterwards. It is important to point out that our cohorts are not medical students, but microbiology majors, medical science and biomedical science students, though a significant number go on to postgraduate medicine programs. This 'big picture' approach engages our diverse cohort of students – and both anecdotal and evaluation data confirm this, as supported by these comments derived from a survey of three clinical microbiology units comprising about 200 second- and final-year students as part of the university-wide end of semester learning experience (LEX) evaluation conducted in 2009:

> *I really like the critical thinking required for the patient diagnosis class discussions, they really help you think about how much is relevant for each patient and were quite fun.*
>
> *We were all participating and thinking rather than just listening. Critical thinking questions were gold.*
>
> *Mark has expectations of the students which promote enthusiasm for learning and working to a high standard ... [he] reinforced to the class the imperativeness of being competent in the skills required for working in a diagnostic laboratory and*

Figure 1. Teaching and learning integration in clinical bacteriology: Developing and refining critical thinking (CT) and complex reasoning (CR) skills.



furthermore the skills and knowledge required for this vocation were taught in a very concise way through the format of the interactive lectorials.

Mark really helped me to understand the 'real-world' applications of bacteriology – rather than just injecting us with hours of theory.

I like that Mark challenges our critical thinking and takes time to explain where we are going wrong. It is made very clear how the lecture material correlates with the lab and real-life situations, the importance of decision-making and reporting in a lab.

Report form compilation in the second half of the lectorial is part of the students' laboratory preparation; hence the innovative concept of the lectorial being a 'dry lab' experience. Students go into the laboratory ready to continue processing a specimen, with a working knowledge and understanding of the key concepts that underpin the practical activities to follow.

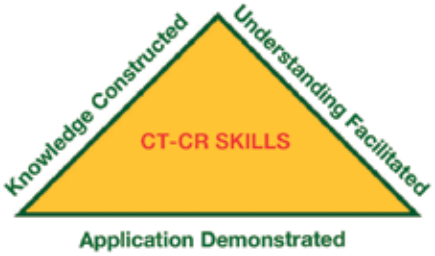
The 'wet lab' experience comprises two key elements: (1) Specimen processing and (2) CT-CR scenarios. The objective of (1) is to train students in the fundamental techniques of conventional diagnostic bacteriology by allowing them to work up a clinical specimen hands-on and in so doing sleuth out the identity of the infectious agent, report on its significance and provide general patient management recommendations.

The CT-CR scenarios are based on a triangulated learning understanding and application (Figure 2). Briefly, in each laboratory session, problem-solving exercises (or scenarios) in the form of a display of relevant laboratory materials or test reactions are set up and students, either independently or as a group, work through them in a type of virtual specimen processing application, answering questions along the way and interpreting data by employing their CT-CR skills. CT-CR scenarios evaluate understanding and application in general and more specifically probe for: scientific rigour, quality assurance, accurate record keeping, technical error detection and data interpretation validation – all key aspects of a real world diagnostic laboratory.

The multifaceted approach outlined in this paper is rich in strategies designed to construct knowledge rather than deliver it, based on the belief that

learning is an active process in which meaning is developed on the basis of experience ... [and] must be situated in a rich context, reflective of real-world contexts, for this constructive process to occur and transfer to environments beyond the school[4].

Figure 2. Triangulated learning context of CT-CR scenarios.



In comparing classroom experiences before and after the implementation of the approaches described in this paper and in analysing anecdotal feedback and preliminary student evaluation data, we have found that overall classroom engagement is improving in measurable ways in our units. That students are using and refining their CT-CR skills is clearly evidenced by the way they answer questions during lectorials, by the strategies they use in the laboratory-based CT-CR scenarios and their performance in formative and summative assessments.

Teaching practices in our units continue to undergo transformations in positive and sustainable ways. Positive because we are now enjoying teaching much more and because we believe (most of) our students are enjoying the learning experiences embedded in our 'fresh' approach. We are also experimenting with different learning experiences by designing spaces and creating opportunities where active classroom interactions are the norm, not the exception. This experimentation is informed by how students engage in the two (lectorials and laboratory) primary integrated learning contexts.

Acknowledgements

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References

1. Bednar, A. *et al.* (1995) *Instructional Technology: Past, Present and Future* (Anglin, G. ed.) 2nd edn, 100-112, Libraries Unlimited, Englewood, CO.
2. Ramsden, P. & Watson, D. (2003) *Learning to Teach in Higher Education.* Routledge Falmer.
3. Douglas, I. (2008). Addressing graduate attributes with an airline management simulation. *Proceedings ascilite Melbourne 2008* At: http://www.ascilite.org.au/conferences/melbourne08/procs/douglas.pdf
4. Handelsman, J. *et al.* (2007) *Scientific Teaching.* W.H. Freeman and Company.

Biographies

Mark O'Brien is a senior lecturer in microbiology at QUT, Chair of the Life Sciences Learning and Teaching Committee and an active Member of the ASM Education SIG. He has been nominated for the 2010 ALTC Program Awards - Innovation in Curricula category – Medical Microbiology Program. Mark has been teaching clinical bacteriology for over 20 years and is committed to innovative and effective practices in learning and teaching.

Stephanie Beames is a learning and teaching developer in the Faculty of Science and Technology at QUT. She has a background in software development and learning design and has worked as a sessional academic at GU and QUT.