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Bridging theory with real world research experience: Co-teaching Engineering Biotechnology with R&D professionals

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A B S T R A C T

This study examined the usefulness of co-teaching with research and development (R&D) professionals to integrate real world research experience into an Engineering Biotechnology course. This research suggests that the need to expose students to post-graduate engineering careers and to prepare them to enter real world engineering is crucial. Two sessions were team-taught by the course lecturer in collaboration with two R&D professionals from local industries. The course lecturer covered the theoretical parts, whereas practicing R&D engineers exposed students to current R&D works. Quantitative and qualitative data on the usefulness of the co-teaching sessions were collected from students and R&D professionals' surveys, a student interview and peer observation feedback. It was found that bringing R&D professionals into the Engineering Biotechnology class positively impacted on students' learning. A comparison was also made between the two co-teaching sessions. The evidence showed that managing the lecture and deliverables, and dividing the tasks along the lines of expertise is the key to providing a successful co-teaching session.

1. Introduction

The new generation of chemical engineers, like their predecessors, will be faced with numerous challenges and will be asked to provide solutions using new and revolutionary tools and technologies (National Academy of Engineering, 2004). With the emerging use of new techniques and technological processes, the role of industrial research and development (R&D) is now seen as critical for the success of any chemical and biochemical industry. This raises the question of what can be expected of new chemical engineers joining the R&D sector of chemical/biotechnical companies? How much knowledge about new applications and novel processes should these students have gained through their university courses? According to Ostrander (2015) it is the responsibility of academia to educate and prepare students in the latest methods being used in industry and to help them understand that the work they do in the classroom is not only important but will also be useful to them in their future employment. Helping students to recognise the relevance of their coursework to their future work in the real world can be viewed as 'customer service'. Universities have become a globalised part of a service-oriented culture where students are customers and academics are service workers (Macfarlane, 2006; Scott, 1999). Macfarlane (2006) places student service at the base of what he calls the 'service pyramid', as he considers this

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to be an important form of academic service. At the next level of the 'service pyramid' are collegial service, institutional service, professional service and public service, respectively (Macfarlane, 2006).

Recent studies on engineering education have shown that in order to prepare students to enter real world engineering and to meet these new challenges, the education practice should integrate technical knowledge and skills of both practice and research (Sheppard et al., 2009; Tenenberg, 2011). In other words, to prepare today's engineers for their future careers, these authors suggest engineering educators and practicing engineers teach together. They further indicated that educating new engineering students about the responsibilities, activities, and projects they may encounter as practicing engineers will have an impact on their desire to continue in engineering (Sable et al., 2014; Traum and Karackattu, 2009).

According to the Washington Accord, which is essentially an international quality mark for engineering education programmes, engineering education should include the least knowledge and provide more opportunities for students to gain experience in industry.

In New Zealand, this view is endorsed and recommended by the Institution of Professional Engineers (IPENZ) and the Institution of Chemical Engineers (IChemE) through their professional accreditation, which requires (i) improved industry-academic links and (ii) the integrated development of key contextual skills and knowledge that underpin professional practice (IChemE, 2011; IPENZ, 2009).

Today, many universities are actively involved in research collaboration with industries. Engineering educators, students and companies are connected through technology transfer, industrial partnerships, student internships and mentoring (Mak, 1995; Watson-Capps and Cech, 2014). At the University of Auckland, New Zealand's leading research-intensive university, industry and businesses in the engineering sector have significant interactions with the university in providing curricular advice, as guest presenters and workshop facilitators, and in facilitating students to connect with industry through networking and internships. Students, according to the University of Auckland Graduate Profile (2009), are expected to obtain the following general attributes and values by the time they graduate: (i) a mastery of a body of knowledge, including an understanding of conceptual and theoretical elements, in the field of study, (ii) an understanding and appreciation of current issues and debates in the field of study, and (iii) an awareness of international and global dimensions of intellectual, political and economic activities, and distinctive qualities of Aotearoa/New Zealand. To help students attain these attributes, the University of Auckland is exploring ways to deliver programmes and new pathways in close collaboration with industry.

D'Este and Perkmann (2011) discussed the benefits that faculty members gain from the influx of corporate expertise, and how students gain knowledge about high-throughput technology and commercial applications. Although engineering academics have expertise in teaching and research, they often lack the up-to-date knowledge of industrial practice. Merritt (2001) considers that universities should include new techniques in industrial research in lecture courses, and present them by visiting lecturers able to give an industrial perspective on these issues. Tenenberg (2011) introduces the idea of using 'industry fellows', which pairs an industry professional and a university lecturer to co-teach a course. The advantages of this approach are the strengths of each co-teacher in addressing the challenges related to bringing real-world experience into the class. Ostrander (2015) adopted the 'industry fellow' model and investigated the impact of the approach on the students, the industry partners, and the lecturer. She found that the co-teaching approach had a significant positive impact on all participants. The students put more time and effort on their projects when an industry partner participated and this resulted in an enhancement in the quality of resulting project (Ostrander, 2015).

The central hypothesis which underlies this study is the connection between the classroom and 'real world research' to provide students with the technical and practical information occurring in industry. The hypothesis is based on the premise that students will benefit from being exposed to the additional perspectives that R&D professionals provide and can positively affect students' motivation to learn as well as recognising the relevance of their coursework to the real world. In this way, exposing students to R&D practitioners enables them to picture, reflect upon, and make informed decisions about their potential future careers as practicing R&D engineers. Thus, the objective of this study was to investigate the usefulness of integrating real-world R&D practice into the classroom by co-teaching with R&D experts. A study was set up to assess the applicability and usefulness of the co-teaching approach with R&D professionals from the students' point of view and whether the sessions taught were successful from the peer observers and lecturers' viewpoints.

2. Methods

2.1. *Human research ethics*

Approval for the study was obtained from the University of Auckland Human Participants Ethics Committee (UAHPEC).

2.2. *R&D partners*

It is challenging to find R&D professionals who have the time or the relevant expertise necessary to collaborate in instructing a university course. The R&D biochemical engineering scientists who participated in the co-teaching sessions were from a local industrial R&D company and a research institute. These scientists were selected because of their distinguished domestic and international careers in the areas of industrial and R&D biotechnology, as well as their expertise and professional strengths. The invited R&D professionals have no link to the University of Auckland and are not alumni of the university, although this was not a considered factor at the time and could be an opportunity for further invitations.

The first R&D scientist is from New Zealand Crown Research Institute with expertise in the area of bioreaction engineering including reaction and transport phenomena, bioreactor analysis and process scale up. He has an impressive record of developing innovative technologies and is responsible for leading the research direction for the development of new and emergent environmental biotechnologies in New Zealand. The second R&D scientist is involved in innovation research and from a large and long established New Zealand food company. This R&D professional has expertise and industrial experience in the development and application of innovative technologies in the fields of biotechnology, separation processes and food processing. The university has good relationships with both companies and is already