Chapter 2
Problem-Based Learning Curricula in Engineering

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ABSTRACT

This chapter explores Problem-Based Learning (PBL) curricula in engineering in Australasian universities, in particular its effects on student approaches to learning in PBL teams. Exploring from the three view points: curriculum design and implementation; institutional support structures assisting the transition to PBL for both students and academics; and student learning experiences in PBL teams, this chapter intends to close the loop for institutions and academics using PBL to educate future engineers. In particular, this chapter examines the design of engineering PBL courses or subjects within programs and the ways in which learning experiences are designed for students, the support structures that institutions put in place for both academics and students to transition to PBL, teacher practices and student experiences of learning both individually and as a team in PBL. It is argued that many engineering programs still undermine the need for designing learning experiences to help students achieve the desired learning outcomes; seldom consider the learning cultures adopted by PBL teams and how students engage in learning as individuals and as a team. This chapter argues the need for approaches to PBL that enhance student learning and experiences in engineering and the need for support structures that assist both students and academics in the transition to problem-based learning.

INTRODUCTION

Professionals tend to work in environments that continually attract change and innovation. This is particularly true for engineering as technology is continually invaded by change. In a fast changing world, the ability to generate ideas to create products and solutions to problems that satisfy social and consumer demands needs a creative dynamic between knowledge-creation, entrepreneurialism and consumers. Without new knowledge, there will be no products or services to offer, and possibly no effective platforms through which to deliver them. Without entrepreneurialism, it is not pos-

DOI: 10.4018/978-1-4666-0951-8.ch002

sible to take advantage of the potential or benefit within new knowledge and take that to market. Without take-up by the market, be that social or economic in conception, innovation will merely be novelty (Smith-Bingham, 2006).

Engineering is a field of knowledge and endeavour in which likely technological changes and challenges impact the world and influence the engineering profession (Schön, 1983). In the last hundred years, our world has changed steadily and more rapidly than it has in the preceding past. It has become a healthier, mostly safer and an extremely productive place, where engineering through technology has forged an irreversible imprint on our lives, identity and the society. Modern engineers revolutionise the world by engaging in all phases of simple to often incredibly complex lifecycle of products, processes and systems that have one feature in common—they meet the changing needs of society.

Consequently, the engineering industry expects engineers to find not only engineering solutions to a problem, but also economic solutions that have a high potential of being successful. The new skills and perspectives required of engineers are expected to extend their broader leadership role, as the expectations of the technological world on engineers are higher than in the past. Yet, engineers commonly do not reflect critically on social issues; nor are they asked to consider these issues at university. Indeed, universities often design and implement engineering courses that are quite successful in training students with diverse views to adopt a stereotypical technology-oriented view (Hadgraft, 1993).

However, today's engineering industry measures an engineer's knowledge and skills not only from the breadth and depth of disciplinary knowledge, but also from the individual's experience in developing personal and professional skills and the ability to work with other engineers and with colleagues from other disciplines (Crawley, Malmqvist, Östlund, & Brodeur, 2007). Simultaneously, engineers are also expected to address contemporary challenges such as innovation and sustainability or sustainable development, which emerge in high importance for both engineering and engineering education.

If our engineering graduates need to succeed in this changing environment, are we preparing them for it in the classroom? Can the learning that takes place in the protected environment of a tertiary institution be transferred into other, rough-and-tumble learning contexts? How do we help students continue to learn when no longer under the supervision of their lecturers or tutors? To address these issues the engineering curriculum requires major rethinking. That is, it requires restructuring of engineering programs, reallocation of teaching and learning resources, and refocusing of faculty and professional society time and energy to strengthen the educational infrastructure and to educate engineers to tackle the challenges of the future.

Engineering education stands to be marginalized if the education system is passive. The education that we provide to engineers must prepare them to be more than merely fulfilling a technological function. It needs to prepare engineers to become leaders in making wise decisions about technology and policies that will foster innovation. Best practice Engineering education relies on designing and implementing effective courses and programs of study and providing a variety of conducive, enriching and authentic learning experiences for students (King, 2008).

This chapter focuses on relatively recent paradigm shift to problem-based pedagogical approaches in engineering education and its effects on student learning. Studying the problem-based engineering curricula from three view points: curriculum design and implementation; institutional support structures to assist academics and students to transition to PBL; and student learning in PBL teams, this chapter attempts to close the loop by inviting institutions and academics to consider some of the potential challenges that are identified here and how such challenges may be addressed in their own contexts.